Tappi

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OCTOBER 1959

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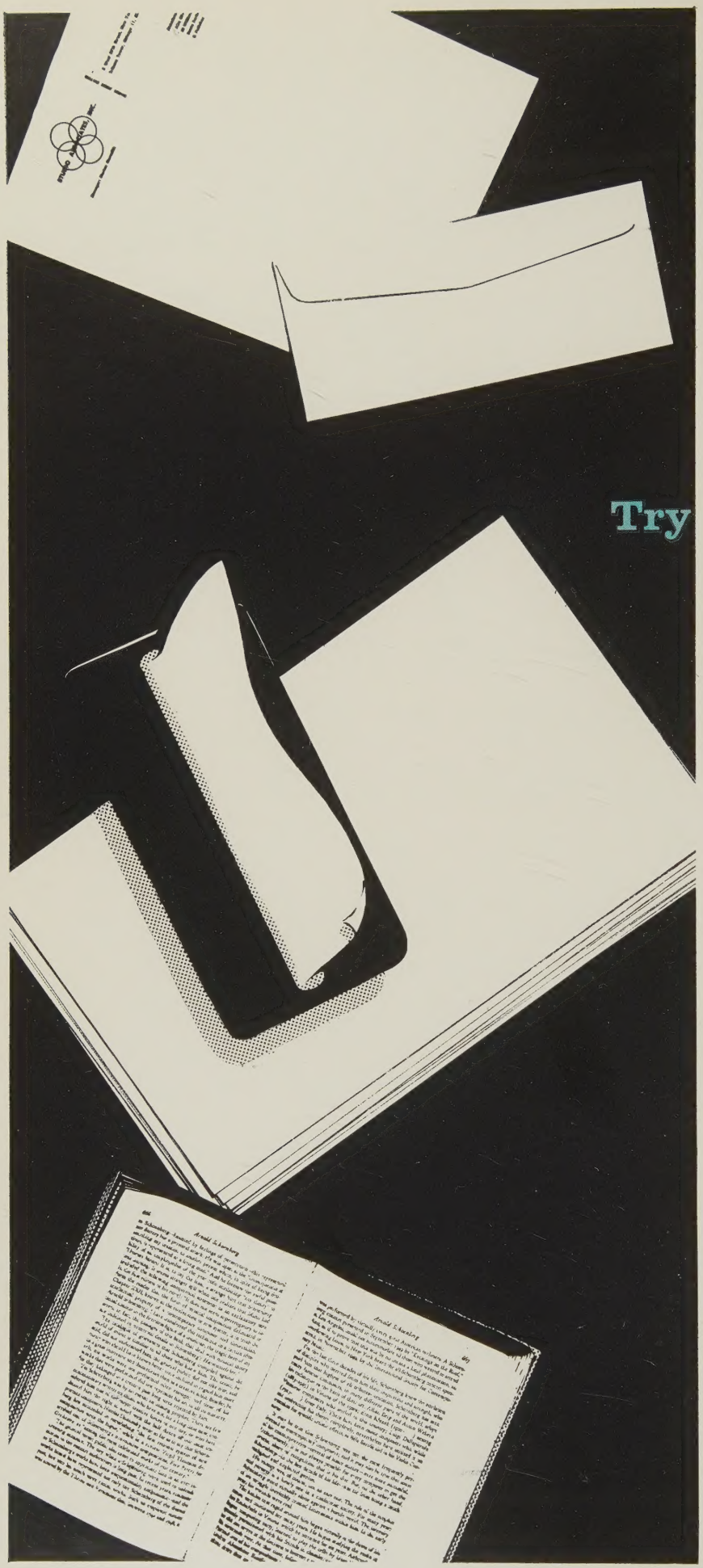

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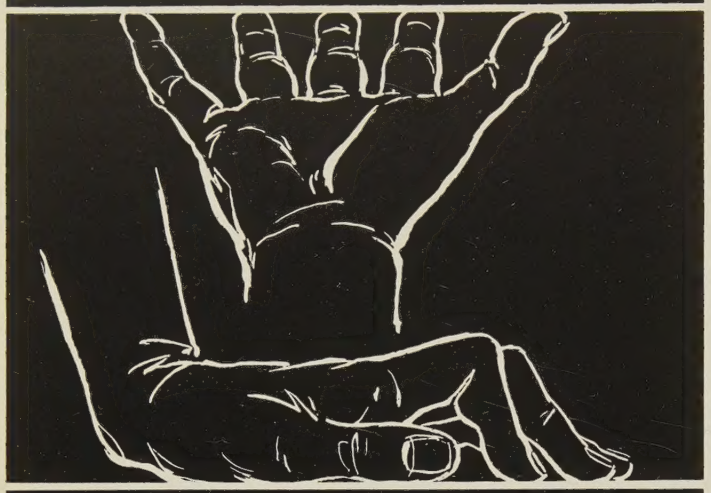

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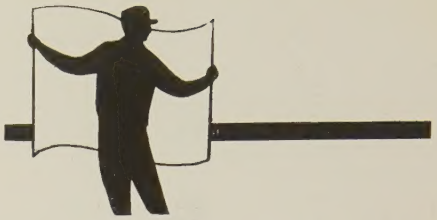

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HOW? By replacing part of the bleached sulphite with

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PAPERAIDS

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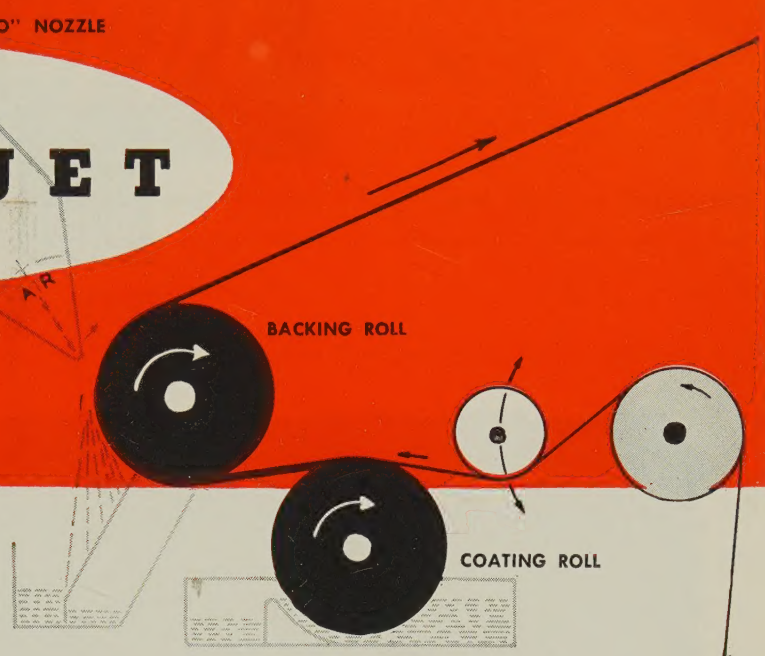
MICROJET

the COATER *where the metering is done by high velocity air*



. . . and a clean, smooth, uniform job of metering it does, too! The accuracy is exceptionally high!

The quality of coat coming from the MICROJET Coater is exceptionally fine, being completely free of scratches or other surface imperfections. The economy is high in that maximum coverage per pound of coating is obtained.

The WALDRON MICROJET Coater can be installed actually on or immediately in series with the paper or board machine, if so desired. The finished sheet would require no further converting.

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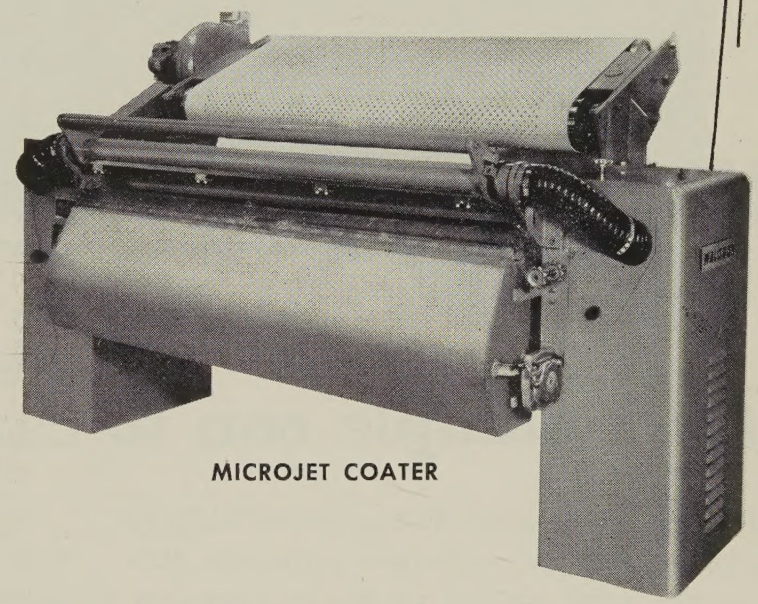

MICROJET COATER

"ON-MACHINE" USERS OF THE MICROJET

	No. of Units		No. of Units
International Paper Co.	4	Waldorf Paper Co.	2
Container Corp.	1	Gulf States Paper Co.	1
Regal Paper Co.	1	Potlatch Forests	2
Olin Mathieson	1	Alton Box Board	1
E. Texas Pulp & Paper Co.	2	United Board & Carton	1
Sutherland Paper Co.	2	Union Bag-Camp Paper Corp.	1

M-R

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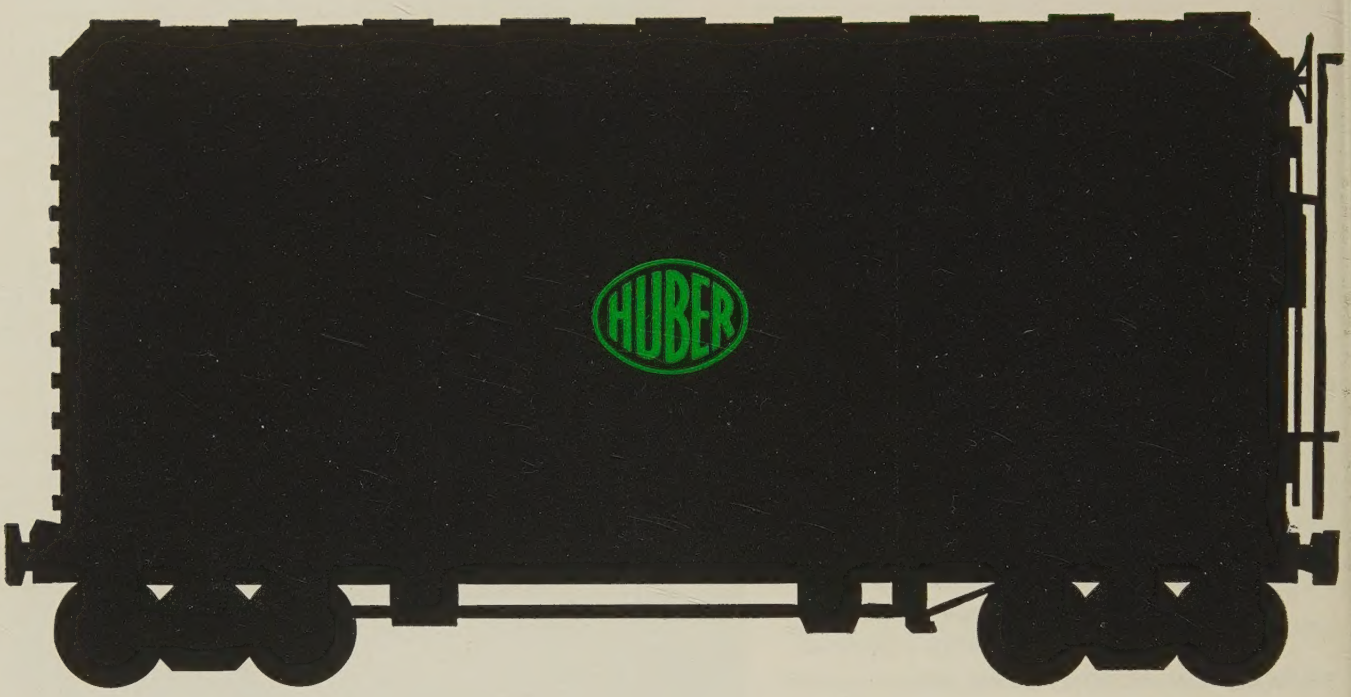

from sample can to carload in one year

Rarely has a new material been accepted so readily by paper and boxboard manufacturers as Hydrafine. Mills that tried sample cans last year are now ordering carloads of this new coating clay!

In *paper coating*, Hydrafine excels in developing high brightness and gloss. In *boxboard coating*, Hydrafine gives maximum brightness and covering power at low coat weights. A clay of *extreme fineness*, Hydrafine is spray-dried in the pre-dispersed form preferred by many manufacturers. Hydrafine is also available in lump and pulverized form.

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Particle size—90-94% finer than 2 microns
GE Brightness—86-87%
Controlled low viscosity, as in all other Huber clays.

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Clays and printing inks for the container industry.

OCTOBER 1959

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The Technical Articles are in accord with the recommendations of the Division of Pulp, Paper, and Board of the International Union of Pure and Applied Chemistry.

Photo courtesy Sorg Paper Company, Middletown, Ohio

Easy solution to "tough paper" problems

Plasticized printing papers represent a recently awakened field of opportunity for fine paper producers. Interest is running high in these tough, durable sheets for book covers, tags, labels, maps, charts, signs, banners, calendars, menus, games, bumper strips and other applications where rough usage, weather or repeated handling and folding are involved.

High strength and unusual flexibility plus resistance to moisture, soiling, fading, aging, tearing, cracking and fraying are the properties these versatile papers have in common. These mutual advantages spring from the general use of a latex-based impregnant, but can be varied by the individual manufacturer. And here's where you can pick up a prime pointer in the form of CHEMIGUM LATEX.

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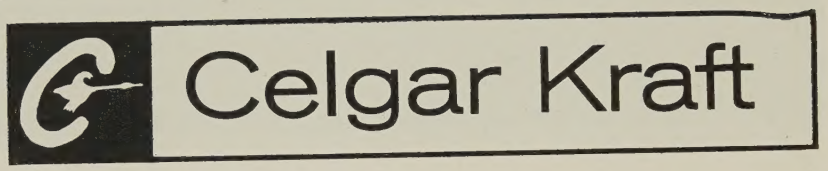
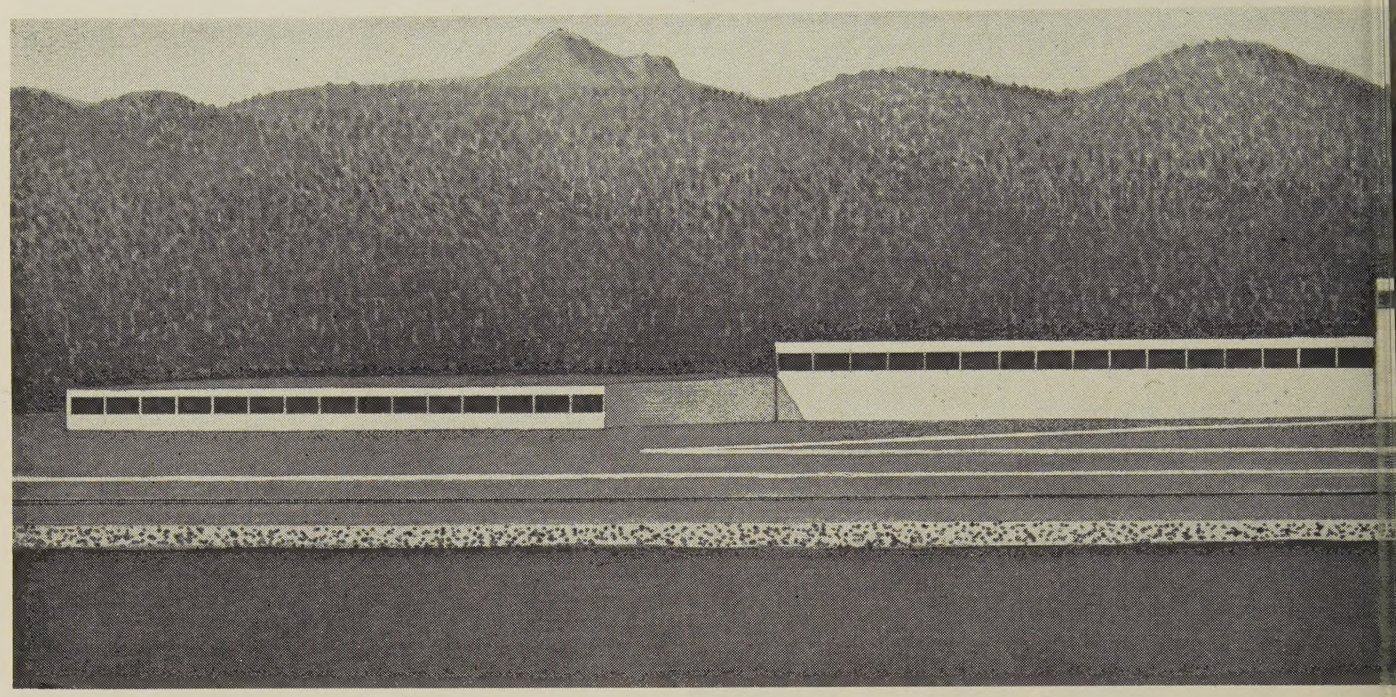
GOODYEAR
CHEMICAL DIVISION

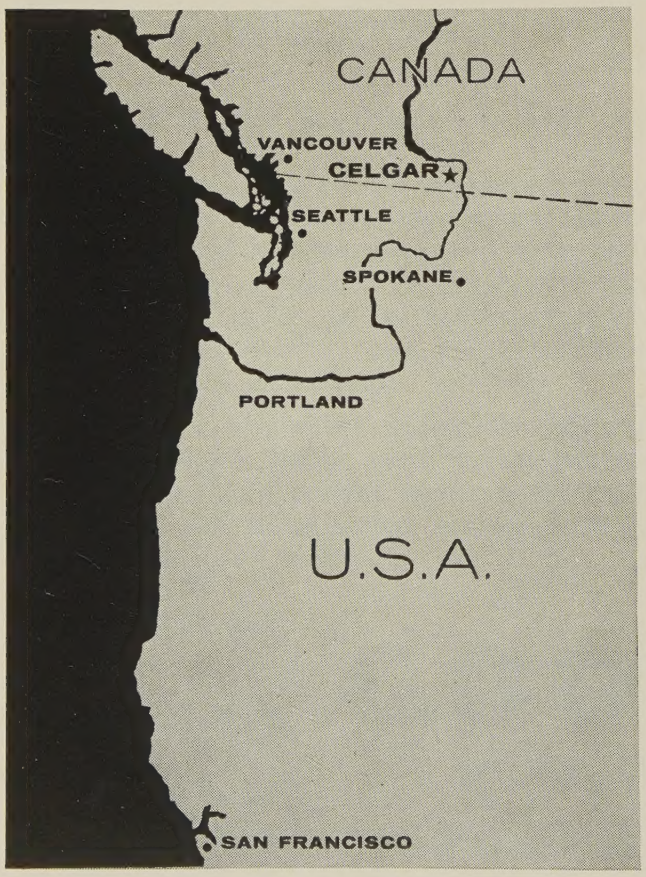
Chemigum—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio


Celgar Kraft

IN 1961 . . .

A new source of Canadia





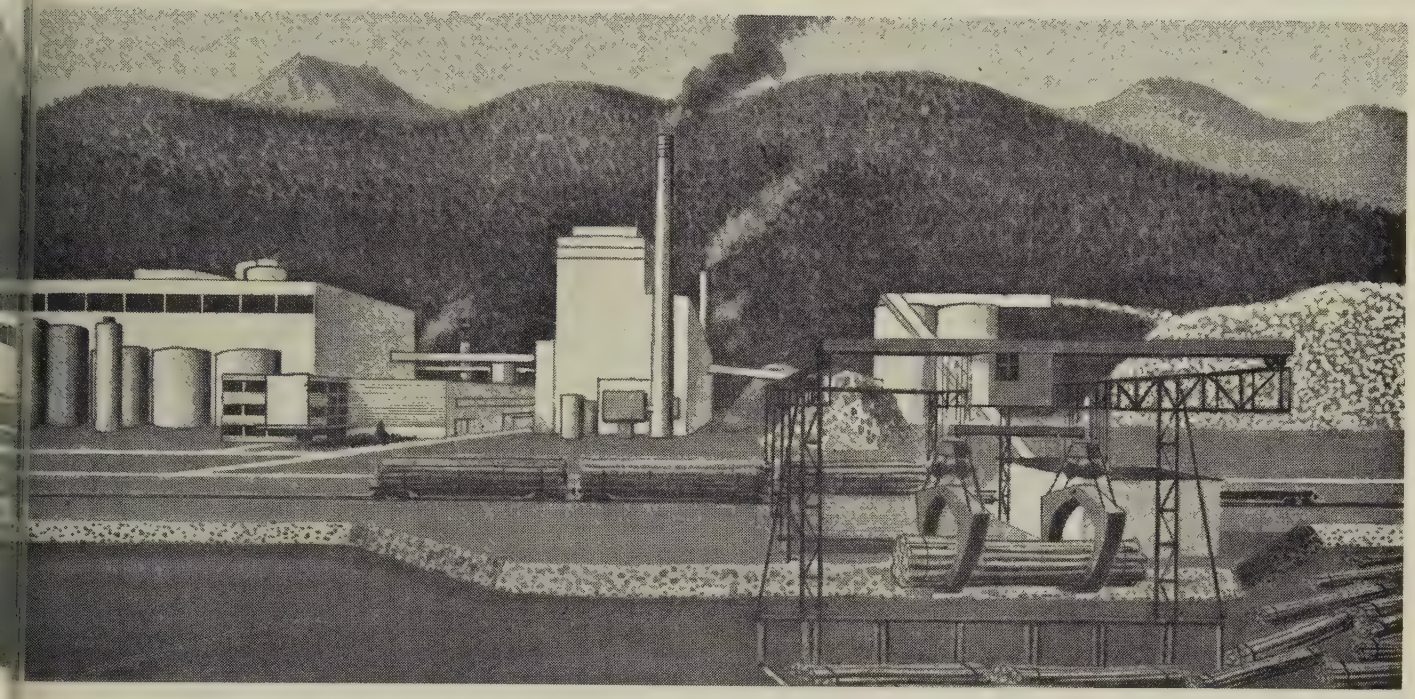
Who is CELGAR?

Celgar Limited is a Canadian company affiliated with the Celanese Corporation of America. It was incorporated in September, 1951, to establish a forest products industry in the Arrow Lakes area of British Columbia, and now operates two sawmills on the Columbia River. Celgar's associate company, Columbia Cellulose Company, Limited, operates a dissolving grade sulphite mill near Prince Rupert, on the northern coast of British Columbia.

Where is CELGAR?

Celgar's pulp mill, with new sawmill facilities adjoining, is under construction on the Columbia River just two and one-half miles west of Castlegar, in the southern interior of British Columbia. The Company's Tree Farm Licence area stretches 200 miles through the Arrow Lakes District to the north. The Columbia River, which drains the Arrow Lakes Basin, crosses the U.S. border only 18 miles below the mill site, flowing on through Washington and Oregon to the Pacific.

larket Bleached Kraft Paper Pulp



500 TONS DAILY

Early in 1961, Celgar's new high quality market pulp mill will go on stream. It will have a designed daily capacity of 500 tons of bleached kraft paper pulp.

Celgar holds in perpetuity almost 900,000 acres of productive forest land containing large volumes of pulpwood species such as hemlock, spruce, Douglas fir and balsam. Adjacent timber lands contain more than three and one-half times the pulpwood volume of the licence area. These wood resources ensure that Celgar has the ability to meet future demands. The total wood supply could support over 1,500 tons of pulp production daily in perpetuity.

THE QUALITY OF CELGAR KRAFT

The quality characteristics of Celgar Kraft have been established through a continuing program of wood sampling, pulping, bleaching and papermaking in Celgar's own laboratories and in the experimental plants of independent pulp and paper organizations. The long, tough fibres from high-density softwoods develop high bursting strength coupled with outstanding tear resistance over a wide range of freeness and in a variety of stock preparation equipment. The modern Celgar process design and equipment will preserve these inherent characteristics while achieving the highest level of brightness, cleanliness and uniformity to meet the exacting demands of the trade.

COLUMBIA PULP SALES LIMITED has been formed to distribute Celgar Kraft pulps and Columbia Cellulose sulphite pulps. Offices are located at:

1030 West Georgia St., Vancouver 5, B.C. (MU 4-8311) 1600 Dorchester St. West, Montreal 25, P.Q. (WE 5-1112)

PAPER DIVISION

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Head Office & Works: LACHINE, QUE., CANADA—P.O. BOX 220, MONTREAL, QUE. Branch Offices: TORONTO • WINNIPEG • VANCOUVER

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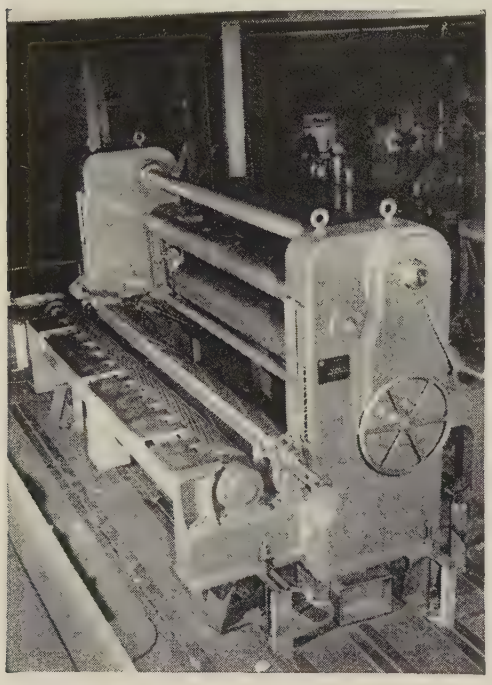
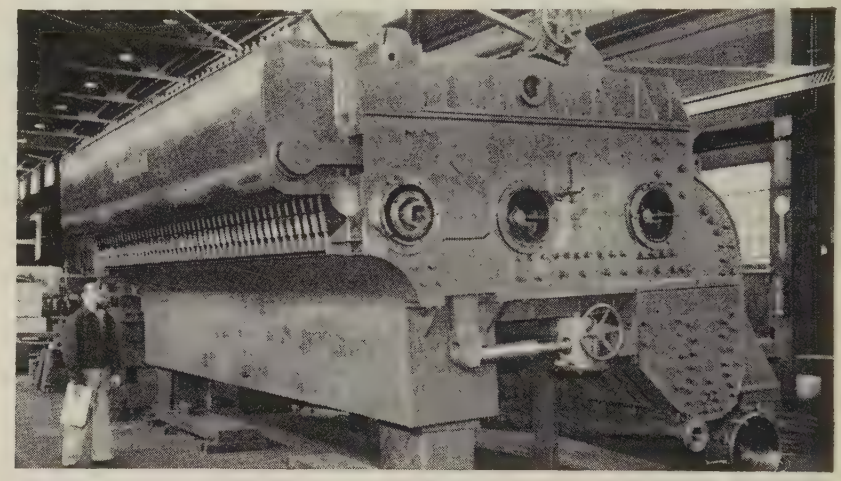
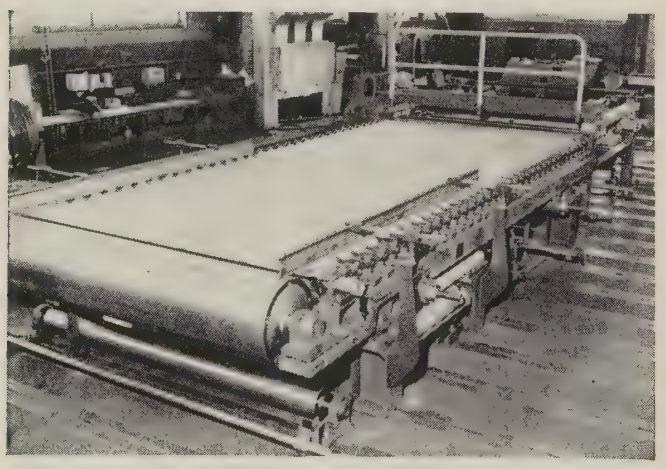


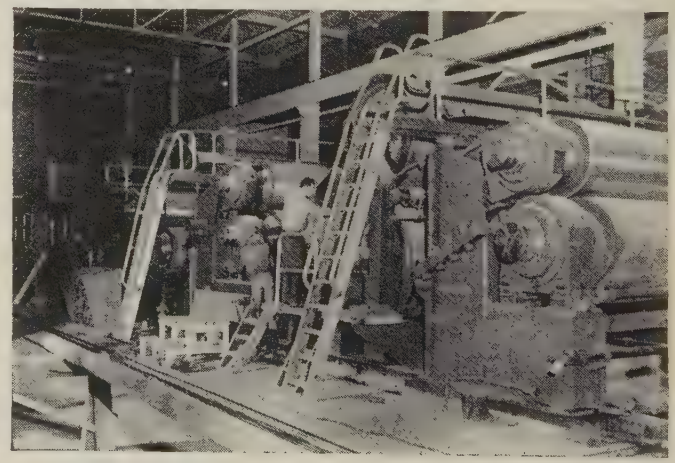
DOMINION WINDERS AND REWINDERS cover the full range from small low speed rewinders to the highest speed news machine winders. Designed to ensure maximum stability under all operating conditions, they incorporate automatic riding roll load control, readily adjustable slitters of either the shear cut or score cut type, a variety of paper unloading arrangements and special winder drum fluting to reduce noise.



DOMINION PRESSURE HEADBOXES incorporate such advanced design features as: fully adjustable slice; parabolic cross-flow distributors and hydraulic rectifier roll drives. Dominion Pressure Headboxes are installed on many fine paper and newsprint machines to increase production and improve product quality.



DOMINION FOURDRINIERS are designed and built to mill requirements: fixed or removable, shaking, which incorporate the patented Torsion Bar Suspension, or non-shaking, etc. Dominion Fourdriniers reduce wire changing time. Most important, complete designing and manufacturing control by Dominion Engineering means total responsibility and service to users of Dominion equipment.



DOMINION SUCTION ROLLS benefit from many years of experience and development and incorporate such features as open ended design for accessibility combined with anti-friction bearings, floating suction box tops and drilling patterns designed to reduce noise level and shadow marking. The shells can be provided in all sizes in bronze or forged stainless steel, the latter permitting the high line pressures available from Dominion oil-hydraulic loaded press sections.

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1112 South Boulevard

Papermaking Pioneering and TAPPI

R. G. MACDONALD

In his chapter on The Beginning of Papermaking (Papermaking in Pioneer America) Dard Hunter named dates that are important. Paper was invented in China as early as 105 A.D. and for hundreds of years the Chinese artisans held the discovery in secret. The invention did not reach neighboring Korea until the year 600, and a few years later the Koreans introduced the craft in Japan. Traveling westward, papermaking was practiced in Samarkand in 751, spreading by the caravan routes to Baghdad 42 years later; then further westward to Egypt in the tenth century, and along the Mediterranean Sea to Morocco, when paper was made in the year 1100. From Morocco the natural route led to Spain where in Jativa, an ancient town of Valencia, the first paper in Europe was made about 1151. In Italy there was a paper mill in Fabriano in 1276, and in Troyes in France, in 1348. Germany's earliest paper mill was founded in 1390 by Ulman Stromer in Nurnberg. In Poland, paper was made in 1491, in Austria in 1498, and in Russia in the year 1576. The John Tate mill was established in Hertford, England, about 1494, and there were papermakers in Dortrecht, Holland, by the year 1586. Paper was fabricated in Denmark in 1635, and in Norway in 1690. The craft of forming sheets of paper in a handmold in the European manner reached the New World without great delay, first in Mexico, in Culhuacan, in the year 1575, by the Spanish; and in Pennsylvania, about 1690, by a German-born family of skilled papermakers.

The very latest of these significant dates is more than 100 years prior to the invention of the paper machine as we know it today. The invention of the so-called fourdrinier machine by Robert in France to make a continuous web of paper and the invention by Gutenberg, in Germany, of the modern printing press with movable type faces seem to separate the past from the present in technological progress. The contributions of these two great inventions to the advancement and distribution of knowledge have been of tremendous consequence.

Down through the years the progress of art of papermaking has been fascinating. The early papermakers depended on raw materials such as bark, grasses, and rags. The great break-through to large-scale modern production came with the discovery of the ways in which wood could be used. The invention of chemical cooking methods and mechanical disintegration of wood released the industry from many of its limitations.

It produced a new type of craftsman who now had greatly increased productivity and who required much broader knowledge of operations, engineering, and some sciences. He was still a practical operator who learned from experience and may have had access to the few textbooks available, especially the book by Hoffman, printed in German and later translated into French and English. The book by Hoffman, written in 1870 seems, even now, to be very modern, even though its wood-cut illustrations give it a quaintness that identifies its date of publication.

Even into the 1920's the operation of the mills of the industry was largely in the hands of capable operators and papermaking families that were skilled craftsmen who started, while very young, to learn the art and the related crafts of papermaking. However, the growth of the industry began to accelerate and the growing demand by users of paper indicated to the industry that it must become ready to meet these requirements whatever they might be. It became obvious that the industry could no longer meet these growing demands without being well informed about the progress of engineering, chemical and physical sciences, and many branches of technology.

In about 1907 the United States Government established its Forests Products Laboratory for the purpose of studying and evaluating various trees as pulp and papermaking raw materials. In about 1920 the University of Maine started its course in pulp and paper technology.

In 1915 a group of men with various kinds of technical training organized the Technical Association of the Pulp and Paper Industry. Not long before this, similar organizations were started in Great Britain, Canada, and other countries. They were all pioneering movements made possible by a rather sudden realization that no small group of individuals nor companies had the know-how to meet the existing and growing demands for the industry's products and the hundreds of new and, at the time, unheard of products.

Today, more than 40 years later, the feeling prevails throughout the industry everywhere that we need more knowledge about everything relating to pulp and paper manufacture and use. In the United States there are at least ten major colleges that train men for the industry. One of these colleges is entirely a graduate school offering the doctorate degree. Research laboratories are now a part of many paper mills. Many companies provide scholarships and fellowships in colleges and some companies have created foundations to support education, research, and public welfare.

In 1929 the Technical Association established its first Local Section. It was organized in the Pacific Northwest, nearly as far away from New York as I am tonight. The industry in the Northwest had grown rapidly. It involved the use of new kinds of woods, that required unique mechanical and chemical handling and treatment. Above all, it needed the cooperative consideration of its technical problems by all the individuals involved.

Since 1929 many other sections have been formed. This year, 1959, a charter was granted to the Gulf Coast Section. When the Association was organized

R. G. Macdonald, Assistant to the President, TAPPI, New York, N. Y.

Tests Prove

that synthetic resin

BILT-REX®

improves the
Printability
of Paper Products

Binds to Cellulose—Does not Stick to Metal

Details on Request

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230 Park Avenue, New York 17, N. Y.

in 1915 there was almost no pulp and paper industry in this region. There are groups or subsections, called districts in such places as Indiana, St. Louis, and San Francisco that will become sections. They represent the modern pioneers who are not only interested in pulp and papermaking but are concerned with new uses for paper and converted products.

Although TAPPI does not indicate in its name or in its services to its members that it is a national organization, a review of its history will reveal that in 1915 it started out as the Technical Section of the American Paper and Pulp Association. For some reason, which probably reflects the attitude of the industry at the time, the A.P.P.A. did not have any desire to have a technical section. Consequently, during that same year the Section idea was abandoned and was succeeded by the Technical Association of the Pulp and Paper Industry. It might have been given a different name at the time, incorporating the word American. In such a case, trivial as it might seem, it is unlikely that I would be at this meeting today.

Partly because of the universality of its name and partly because of its willingness to share its services with all who can benefit from them (and partly because the Association has invited hundreds of individuals to do so) the Association has acquired a large number of members from outside of the boundary of the United States. In fact, about 25% of its individual membership and 45% of its corporate membership is in this category.

Because of its large European membership and because many of these members are located in countries that do not have a similar organization, a group of individuals formed an organization called the Study Group of TAPPI European Members. You are acquainted with this group since you sponsored its annual meeting in 1958. The creation of this study group presented a problem to the Executive Committee of the Association. It presented policy problems. The Association has always looked upon itself as a strictly American society. It felt that the various pulp and paper technical societies in Europe had the same viewpoint. The Study Group was also aware of this dilemma and decided that it would not ask for any status of affiliation. The Association, in turn, offered to be helpful and has been so in a number of ways, such as publishing meeting papers, giving publicity, sending representatives to meetings, etc. The Study Group has been successful and has had good leadership.

In 1956 your speaker attended the meeting of the Study Group in London and also the committee meeting of the European societies that proceeded to organize Eucepa. The Eucepa organization has sponsored excellent meetings. There cannot be too many meeting held for the purpose of exchanging information.

The proposal by Dr. Bersano that a Local Section of TAPPI be organized in Italy and recognized by the Technical Association caused considerable consternation in the Association Executive Committee, but Dr. Bersano is an accomplished salesman and diplomat. He attained all the privileges for which he asked.

The prevailing thought underlying the action of the Executive Committee at its meeting in February was to approve any action that would benefit the industry and increase its technical knowledge. Bringing together technical men who are engaged in the study of pulp and paper manufacturing problems can result only in progress for all concerned.

It is for this reason that I have the privilege of being here, representing the President of the Association, to present you with this Charter symbol, this gavel, and this banner which we hope will remind you that the Technical Association endorses the purposes for which your fine organization has been formed and wishes you success as one of its Local Sections or in whatever form of organization you may, in the future, desire to be.

Charter presentation address, TAPPI Italian Section, Oct. 6, 1959, held at Lake Como, Italy.

45th Annual Meeting
Hotel Commodore, New York, N. Y.
Feb. 22-25, 1960

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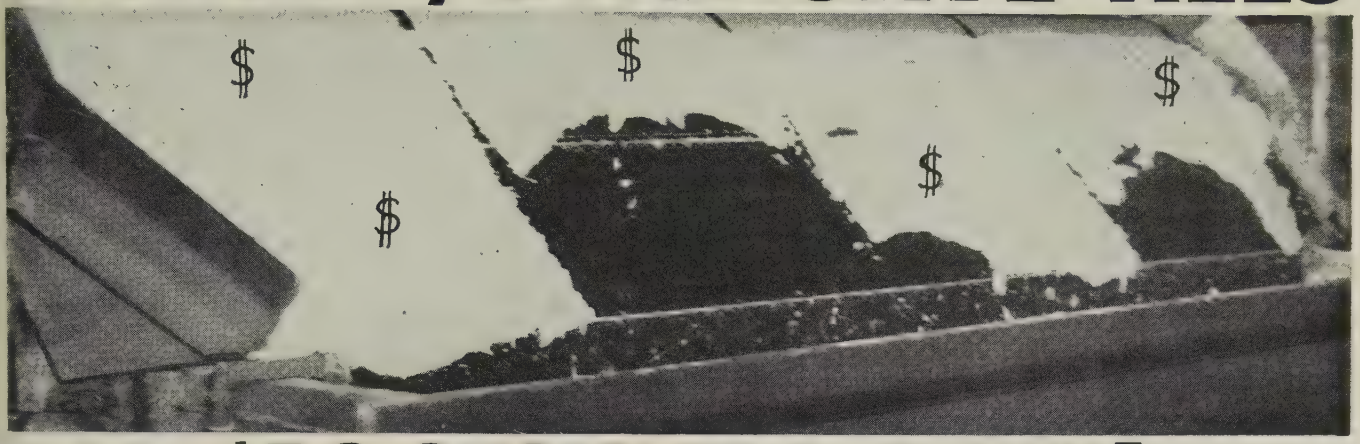

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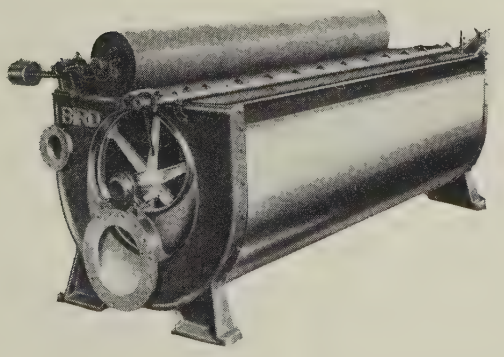

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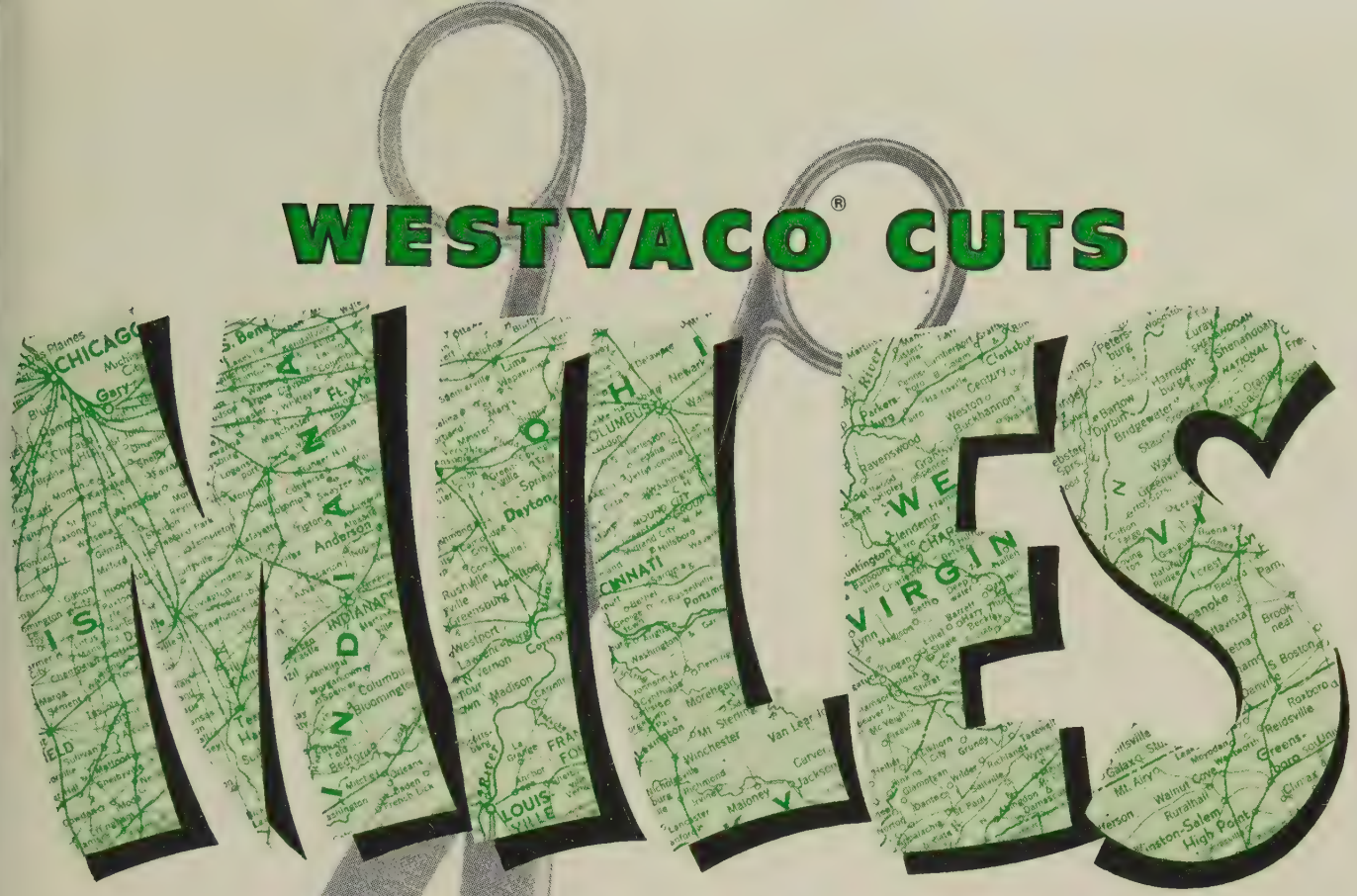

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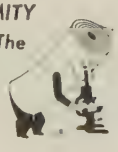

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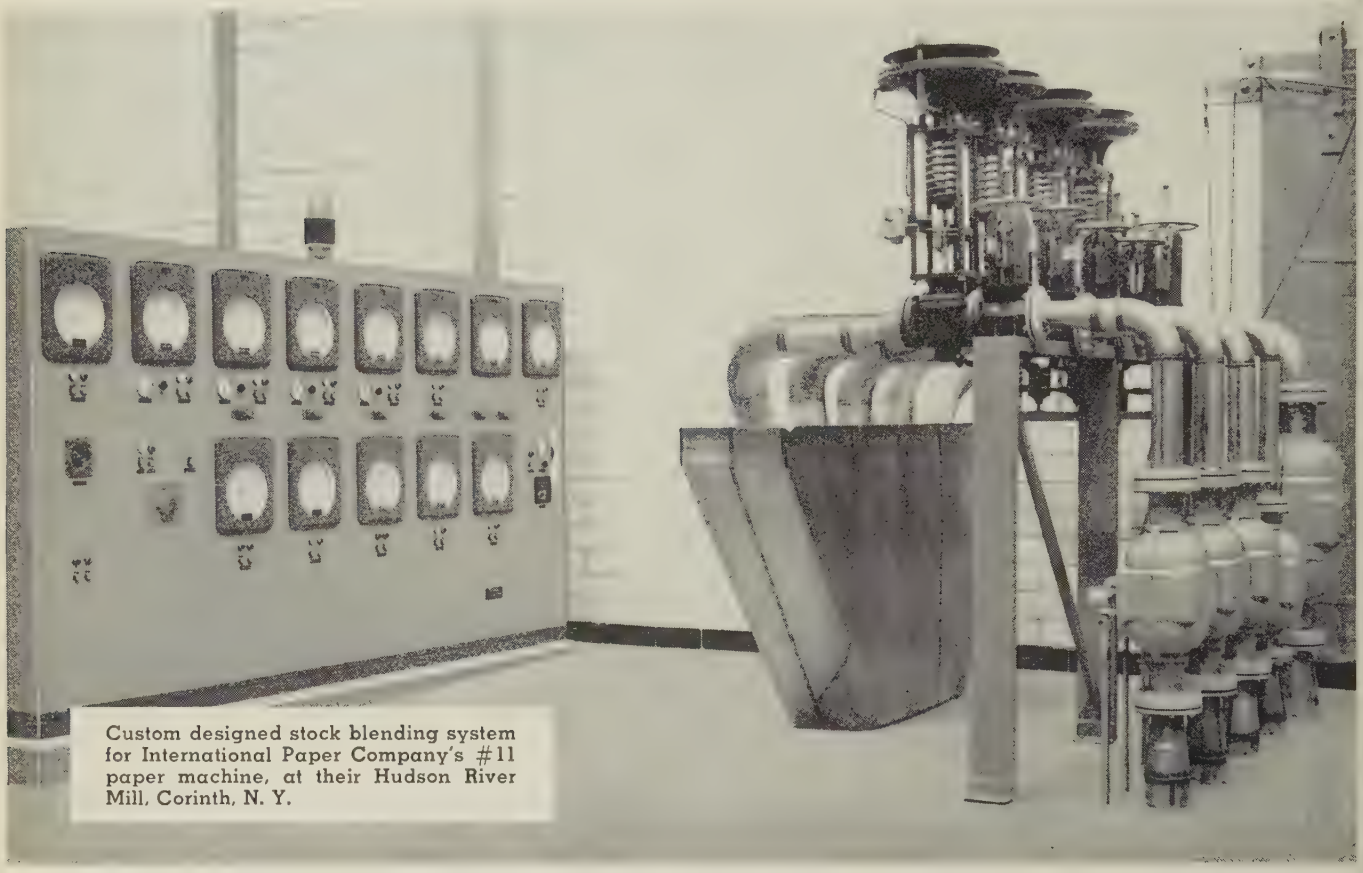

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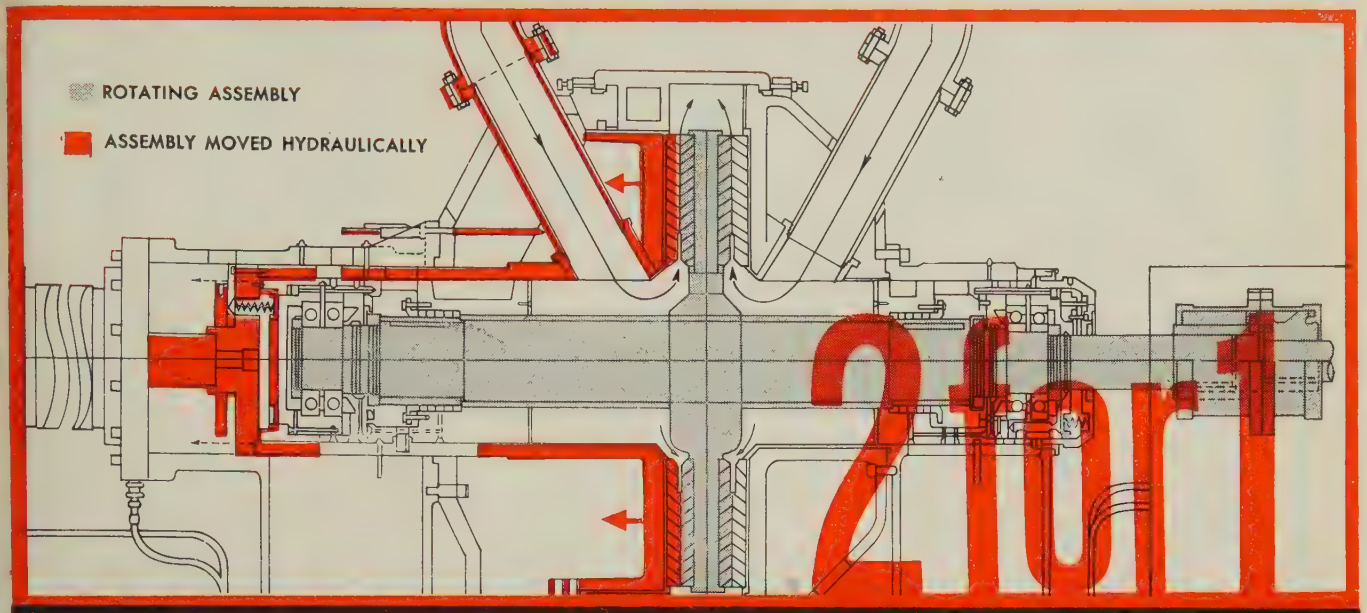

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A Challenge of Industry to the Engineer

J. R. CURTIS

INDUSTRY offers each of us the opportunity to be one of its leaders. However, this offer is not made to us on a silver platter; rather it is presented in the form of a challenge. Those who demonstrate strong and effective leadership answer the challenge satisfactorily, and become the top men in our industry. These men enjoy the rewards of prestige and job satisfaction which do not always accrue to those who are content to follow. My discussion today is directed to those who are sincerely interested in becoming better leaders.

In the few minutes which follow I would like to make two points, viz., (1) for many of us there is considerable room for improvement if we are to meet the technical requirements of an effective leader, and (2) TAPPI offers its members many opportunities to improve their technical knowledge and leadership abilities.

In the short time available I shall not attempt to discuss "leadership" in detail; neither shall I dwell upon the human factors involved. Rather, I should like to stimulate your thinking about the technical aspects of leadership by posing a few questions which each of you can answer silently to his own conscience.

DO YOU KEEP ABREAST OF TECHNICAL DEVELOPMENTS?

Most job specifications for technical people include a phrase in fine print which says "and to keep abreast of current technical developments in his field." How many of us take time to read and to study until we understand the many wonderful developments in science and technology which surround us daily? Could we give at least an acceptable explanation to a high school sophomore of nuclear energy; electronic computers; the universe which envelops us; developments in communications, such as radar and video tape; developments in power transmission, including jet engines and rockets.

It is easy to say that these areas belong to the specialist and have no place in our daily jobs. However, if the pulp and paper industry is to grow, as it must, it will have to take advantage of every possible scientific development. And who is going to apply these scientific principles? The machinery builder? And who will operate and maintain them? The manufacturer?

The industry is going to move ahead, and if outside specialists are required to do your job and mine for us, the industry will not hesitate to call upon them. Is there any question here who is leading and who is following?

The present state of medical science is such that the human body must grow old, and usually the rate of aging is in direct proportion to the body's usage. However the *mind* grows old only when it is *not used*. Are you suffering from mental obsolesence?

J. R. CURTIS, Director of Operations Research, Scott Paper Co., Chester Pa.

DO YOU TAKE ADVANTAGE OF PUBLISHED TECHNICAL INFORMATION?

Today it appears that everyone wants to write a book or publish an article. People want to share their knowledge with you even though their primary motive may not always be philanthropic.

Do you subscribe to magazines devoted to the presentation of technical developments? They cost no more than the literature you pick up in the airport when you are traveling. Do you provide yourself with a good personal library of current technical reference books, or do you console yourself with the thought that the public library, or your company library, is available if a special problem ever arises? Do you maintain a personal file where you keep good technical articles and information for future reference? How frequently do you use your technical library and file?

DO YOU PARTICIPATE ACTIVELY IN TECHNICAL ASSOCIATIONS?

In technical and trade associations you have an excellent opportunity to develop new contacts, to exchange ideas, and to practice leadership. Here are wonderful opportunities to grow in both knowledge and experience.

DO YOU USE TIME TO BEST ADVANTAGE?

Today there is so much to see and to do that none of us has the time to do all the things he wants. And yet, if we are honest, we will have to admit that we do not use our available time to best advantage.

Just think for a moment how much valuable time is lost every day at work through poorly planned and executed meetings and conferences. Or, how much of your evening passes in watching "just one more T.V. show."

Just how much of your day is really effective? 90%? 50%? Or are you in the steam plant class with a 25 to 30% efficiency? If you had a machine which performed with so much "lost time" you would have the manufacturer on the carpet in short order. Efficient usage of time requires two major ingredients, viz., (1) the ability to plan ahead, and (2) the ability to get started.

DO YOU HAVE AN INQUISITIVE MIND?

Intellectual curiosity is a wonderful attribute possessed by too few. Do you have an inquisitive mind and ever seek the reason "*why*?" I am sure that on many occasions you have discussed a common problem with a friend. But have you and your friend in each instance sought to analyze the situation and understand why a particular solution was effective? Or have you accepted Joe's solution on the basis of "It worked for him. Maybe it'll do the same for me." How many tons of chemicals, recommended by men of experience, pass through the sewers of the pulp and paper industry

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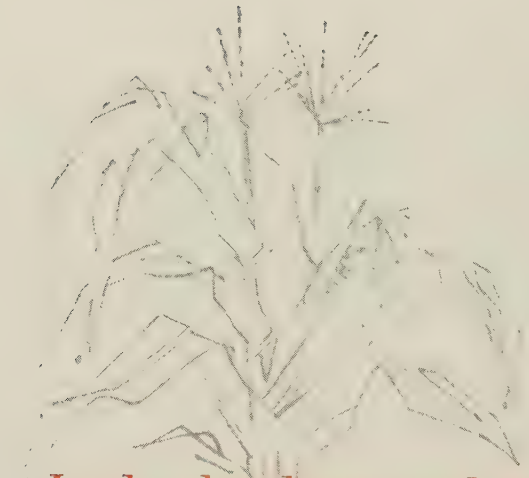

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every year with no sound understanding of the reactions involved, and in many cases with no effect?

In too many instances we enjoy a successful operation and make no attempt to determine why the project succeeded. And when we encounter a failure, we often turn to another approach without attempting to ascertain why the process failed.

If you have taken the trouble to find out for yourself why a problem was solved and have determined the basic facts involved, you'll be able to solve many variations of the same problem. Otherwise you will be limited to one solution based solely on your past experience.

ARE YOU A TRIAL AND ERROR ENGINEER?

Today too many of our engineers, young and old alike, attempt trial and error solutions. Try this. If it works, fine! If not, try something else. Only in America do we have the capital dollars to support such an approach. All too often we start to solve a problem before it has been defined—before we are really sure of the basic cause of our difficulty. Granted, it is difficult to define a problem in many instances; but frequently a problem defined is a problem 90% solved.

Who for example, would want to correct a faulty drier section by adding air hoods and a high pressure steam system when the real problem involved driers full of water due to broken dippers? If you can't define your problem, you are necessarily forced to use a "trial and error" approach which you can always supplement with hope and prayer.

Experience is largely the by-product of "trial and error" approaches. They say there is no substitute for experience, but many of our problems today are too broad and far-reaching to be solved by experience alone. If you think your 10, 20, or 50 years of experience alone will hold the line against the challenge of the new generation with their shiny new academic tools, you are in for a rude awakening. Your experience is the indispensable ingredient for tempering the solutions developed by this new generation of engineers; however you must possess at least a general knowledge of the subject matter. Experience plus knowledge is an unbeatable combination. With either alone you must be a follower instead of a leader.

DO YOU DO A LITTLE MORE THAN THE MINIMUM YOUR JOB REQUIRES?

I have never ceased to be amazed at how much a "little" really is. A "little" is a small quantity but it is not necessarily negligible. A little is often the opening wedge. Think of the researcher who works for years and every result is negative until finally a reaction is a little on the positive side—an indication of a move in the right direction—the opening wedge to a brand new development.

A little movement on our part is the first indication that we have decided to move at all. Once we have started the rest comes much more easily. Procrastination is a dirty word which has cost all of us much more than we will admit.

Consider what the British defense did with their "little" in the last war. A "little" is mighty effective if it is used properly. I often recall an experience years

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By Leonard Rockstrom
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There are literally hundreds of possible combinations of of tension sensing systems, unwind brakes, edge guides and other web control devices. The problem is to make them work together for integrated roll control. For example, a good tension sensing system is of little value unless its responses actuate a properly fitted brake of the right design and capacity. Sensing and braking are useless if edge guides fail to respond or if the rewind method employed does not suit the material.

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ago when several 20 yr. old suction press rolls broke in half from fatigue. At the time I became interested in the possibility of an improved drilling pattern to provide greater strength with the same open area. When I contacted a machinery builder, he was surprised at my concern. Had not the rolls operated 20 years? If I wanted greater strength he would make the new rolls thicker. There was no anticipation of greater speed and efficiency in the years ahead. There was no thought of using a "little" to better advantage. I am happy to add that the machinery builders have since modified their approach to such problems.

One of the primary responsibilities of every engineer is to use a "little" to best advantage, to simplify designs, and to size equipment properly. The engineer is frequently at odds with the papermaker who insists upon spinning all steam and water valves wide open reasoning "If a little is good, a lot is much better."

The pulp and paper industry competes with other major industries for capital dollars with which to grow. The relatively new field of operations research is attempting to secure more for the "little" which remains after taxes, interest, depreciation, and the many costs which eat into our corporate earnings. It seeks to optimize processes of manufacturing, distribution, inventory control, advertising, etc. Contrary to public belief, operations research is not a field for specialists only. Every one of you could apply to good advantage many of the O.R. techniques if you looked upon this science merely as the development of a mathematical expression or model to explain a physical or economic process. Simple arithmetic and algebra suffice to define a surprisingly large number of corporate problems.

The current concept of the term "little" often seems to be to do as little as possible without it becoming obvious. I am sure that many of you have enjoyed the experience of spending an hour in study and preparation before a meeting and then finding yourself the best informed person present. This frequently results in your being elected chairman of the particular committee, and of course you can avoid this if you are satisfied to follow and do not aspire to lead. It's the old mathematical concept that anything, no matter how small, when divided by zero is infinite. As long as your contemporaries are satisfied to do nothing, your "little" will be infinitely greater.

Many chemical processes are triggered or accelerated by a relatively tiny amount of a catalyst. Your small contribution can have a catalytic effect upon others if it is positive and constructive. It's another mathematical fact that the whole is the sum of the parts, and if everyone contributes a "little," a substantial whole will result. However, in order to be additive the little parts must all be positive. A blunt attitude of "That won't work" frequently has the odds in its favor, but it alone contributes nothing to the solution of the problem. It's unfortunate that we are usually much more eloquent and effective when being critical in a nonconstructive way.

TAPPI OFFERS OPPORTUNITIES FOR LEADERSHIP

Let us now look at TAPPI, and more specifically at the Engineering

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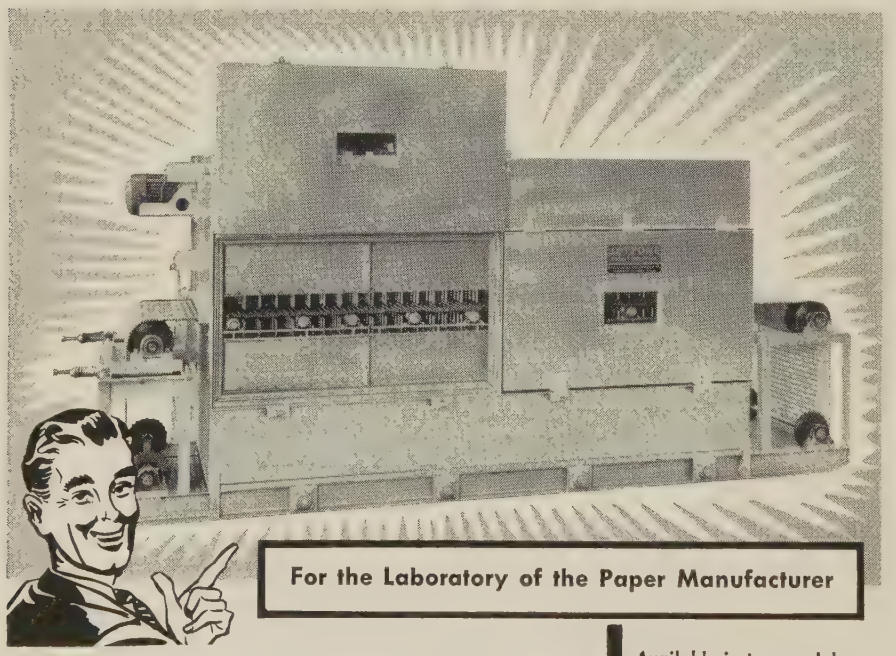

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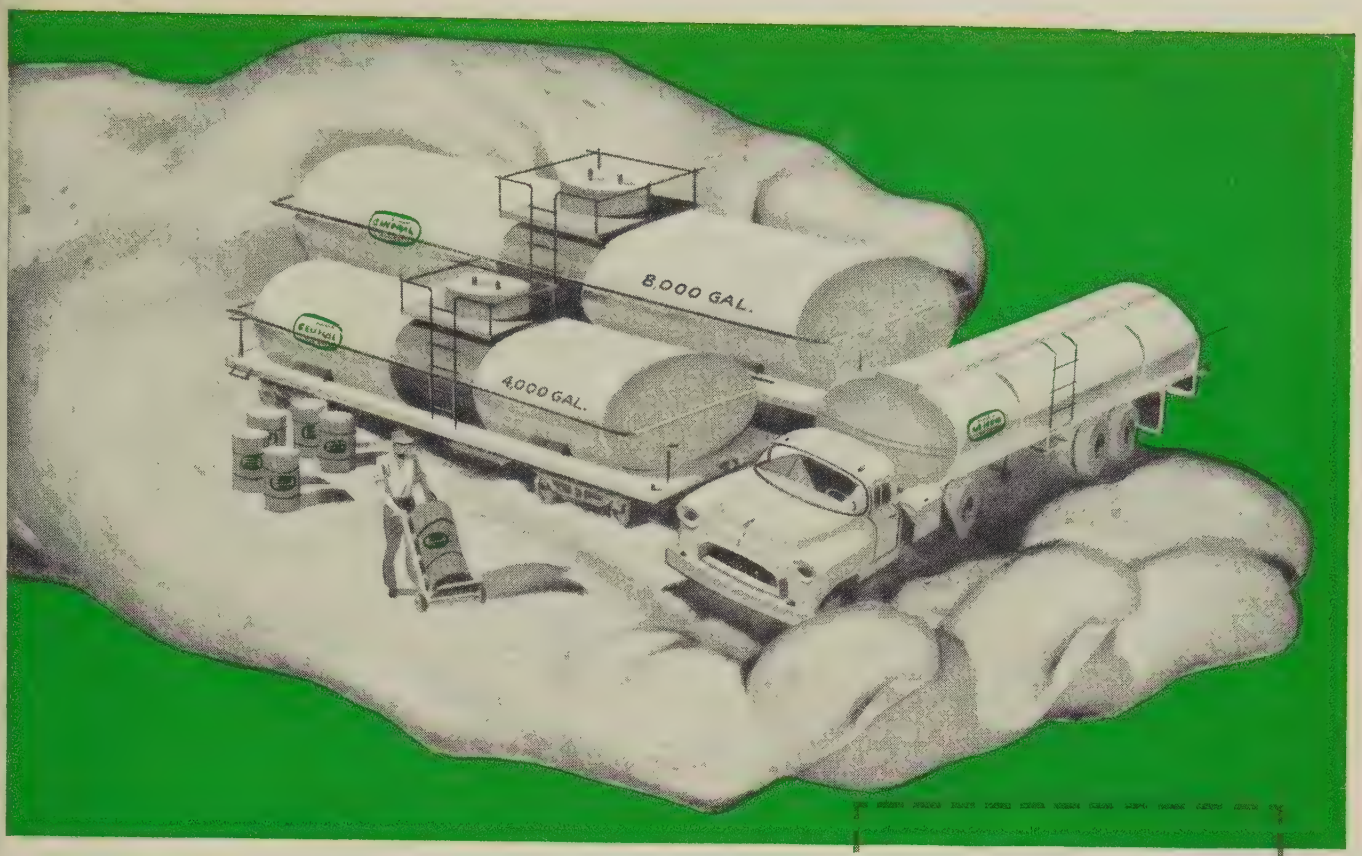
- Two eight-foot long drying zones.

JOIN THE INDUSTRY...INVESTIGATE THE NEW TECHNIQUE OF HIGH VELOCITY DRYING

"TAKING THE MYSTERY OUT OF DRYING"
WOLVERINE EQUIPMENT COMPANY
31 MAIN ST., CAMBRIDGE 42, MASS.

A Leader in High Velocity Drying Since 1946



TO MEET YOUR NEEDS . . .

GEN-FLO® OFFERS BOTH TOP QUALITY AND INDIVIDUALIZED SERVICE

To help you keep latex inventories within reasonable limits, Gen-Flo is available in shipments tailored to fit *your* production requirements. Whether your need is for drum, tank truck, or tank car quantities, Gen-Flo is ready to serve you now!

Gen-Flo, the "balance-controlled" styrene-butadiene latex, comes from an ultra-modern plant, where it is carefully produced and thoroughly tested by skilled technicians to assure the ultimate in quality and uniformity. Prove Gen-Flo's excellence in your own starch or casein paper-coating formulations—write today for literature and a generous sample of Gen-Flo . . . the latex that *makes* outstanding paper.

FACTS YOU SHOULD KNOW ABOUT GEN-FLO

Tested by leading manufacturers, Gen-Flo has been found to offer these advantages for paper-coating applications:

- **Superior brightness**
- **Better pick resistance**
- **Higher ink receptivity**
- **Improved opacity**
- **Better smoothness and gloss**

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CHEMICAL DIVISION
AKRON, OHIO

Creating Progress Through Chemistry

Chemical Division GENERAL THE GENERAL TIRE & RUBBER CO. GEN-FLO®

TC-Hydro is a dry, white, free flowing, crystalline powder of uniform size and structure. It is dust free, assuring highest stability and uniformity.

As Miners Of Sulfur Bearing Ores— We have utilized our basic position in Sulfur Chemistry to produce another product of highest purity and quality for use in the Southern Pulp and Paper Industry.

When You Need It — Our production is located in the heart of the Southern Pulp and Paper Industry which permits us to render overnight delivery service to most Southern points—also small lot shipments are available from centrally located warehouses.

Phone, Wire or Write for literature and test samples if desired.

TC TENNESSEE CORPORATION

TENNESSEE CORPORATION

617-29 Grant Building, Atlanta, Georgia

Division. Can TAPPI help you to meet the challenge of the Industry for better technical leadership?

I would like to call your attention to a portion of Article II of the Bylaws of TAPPI:

"The objects of the association shall be:

a. To further the application of the sciences in the pulp and paper industry.
b. To promote investigation, research, and interchange of ideas among its members in the field of pulp and paper manufacture and use.
c. To promote education in the science and practice of pulp and paper manufacture.
d. To arrange for the collection and dissemination of information relating to the pulp and paper industry and for the presentation, discussion, and publication of papers and other contributions.
e. To provide technical facts, data, and standards, fundamental to pulp and paper manufacture and use."

TAPPI would like to help all of you to become leaders within your sphere of activity, for only when you are leaders will you, and the industry as a whole, move into a more dominant position. Our primary problem is to marshal the power of the combined experience and knowledge of our 9000 members to improve the status of the members and to drive our industry ever forward.

What is the program of the Engineering Division to help you in this respect? The primary tool at our disposal is our committee project activity. Today there are 14 committees in our division, covering most engineering aspects of the pulp and paper industry. These are:

1. Chemical Engineering Committee
2. Civil Engineering Committee
3. Corrosion Committee
4. Engineering Data Committee
5. Drying Committee
6. Electrical Engineering Committee
7. Engineering Economics Committee
8. Fluid Mechanics Committee
9. Industrial Engineering and Materials Handling Committee
10. Mechanical Engineering Committee
11. Maintenance Engineering Committee
12. Process Instrumentation and Control Committee
13. Sanitary Engineering Committee
14. Steam and Power Committee

As the need arises these committees are expanded and new committees are created. Recently the Hydraulics Committee was expanded to cover the more general field of fluid mechanics. Engineering Economics has been added to cover the important cost control responsibility of the engineer. Our Chemical Engineering Committee is expected to give birth in the near future to an Operations Research Committee. Every one of you should be a potential member of one of our committees or subcommittees.

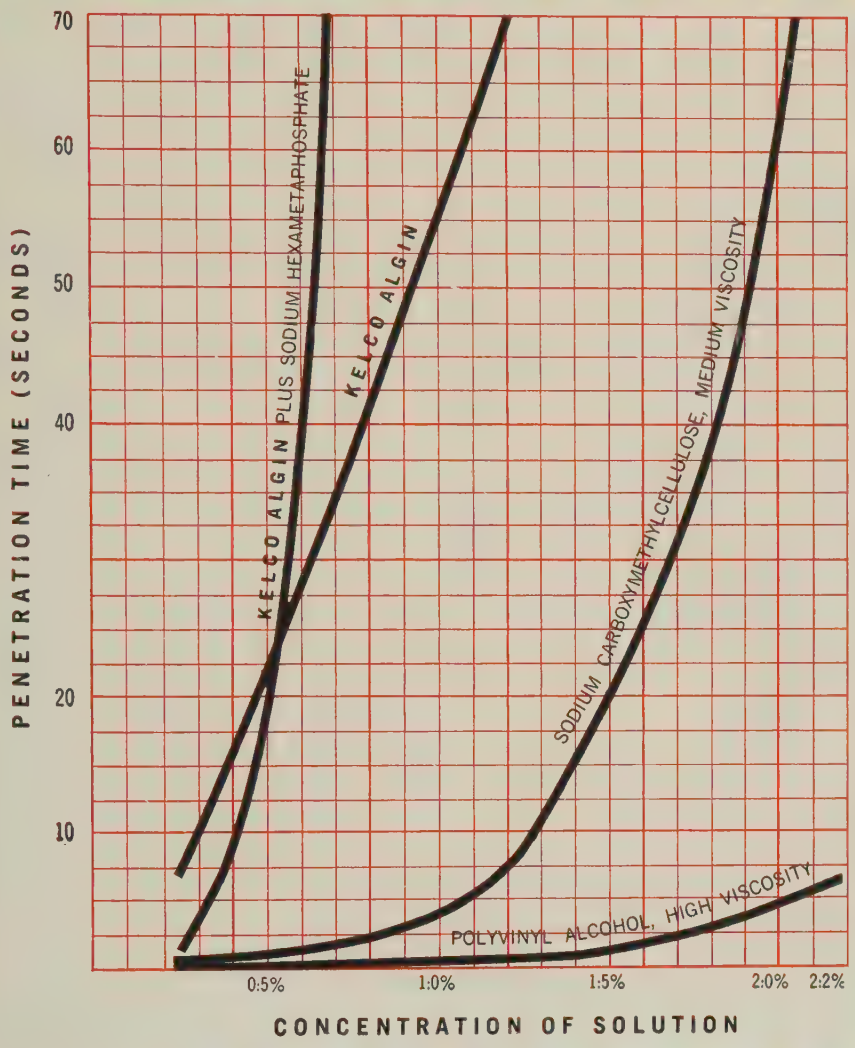
Each committee engages in project activities according to specific plan. These project activities may include:

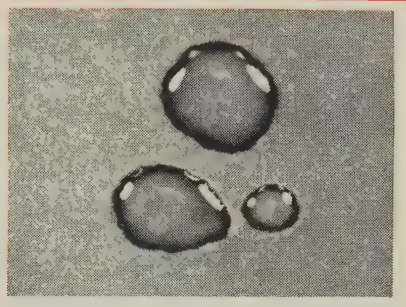
1. Short range research supported by TAPPI funds.
2. Development of Engineering Data Sheets.
3. Preparation of technical papers for conferences and for publications.
4. Procurement of technical papers for conferences and for publication from authorities on particular subjects.
5. Processing of questionnaires.
6. Preparation of monographs.
7. Panel presentations at conferences.

Does this program give you an opportunity to exercise leadership? The Engineering Division can support perhaps 20 committees. Each committee has a staff

Remarkable! The way Kelco Algins give greater

PENETRATION





This photograph shows a 1% solution of Kelco Algin twenty minutes after being puddled on blotter. Note how algin controls penetration and retains solution on surface of blotter. This test illustrates the outstanding ability of algin to control penetration. With it you can get the exact degree of hold-out desired for sizings, coatings, adhesives, inks, etc.

Here is photograph of water, without algin, on same piece of blotter taken seconds after water was placed on blotter. Note how water passed immediately into blotter compared to controlled penetration of algin solution.

CONTROL

This graph and blotter test illustrate and prove that KELCO ALGIN products are among the most efficient materials available for controlling penetration. By using proper proportions of a product such as KELGIN, KELGIN LV, KELGIN XL or KELSIZE, manufacturers of paper products can regulate the amount of penetration of size formulations, clay and wax coatings, printing inks, adhesives, etc. Of course, having your formulation where you want it, without excessive and unnecessary penetration, saves you money.

MAKE YOUR OWN TEST: Samples, information and technical service, yours on request without obligation.

KELGIN® KELGIN LV KELGIN XL KELSIZE S® products of **KELCO COMPANY**

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comprising a chairman, a vice-chairman, and a secretary. Each committee should support 10 projects, each project requiring a subcommittee chairman. Here is a potential golden opportunity for 260 men to practice leadership. 260 men! That's equivalent to every other man at our luncheon today. Committee project work gives our members an opportunity to rub shoulders with other engineers, to exchange ideas, and to grow in stature and wisdom.

Our project activities can be fruitful only if:

1. Committee procedures are coordinated.
2. Each committee has a well-defined program.
3. Committee leadership is vigorous and continuous.
4. Committee members are ready, willing, and able to invest a reasonable amount of personal effort in project work.
5. Adequate financial support is available when required.

I am happy to report that we are making fine progress in all of these areas. The Engineering Division has established a Staff Advisory Committee consisting of members with considerable experience in division administration. This group has been of inestimable assistance to your staff in the consideration of our administrative and organizational problems. For example, the Advisory Committee has prepared an "Engineering Division Operating Manual" which reviews in detail many policies and procedures so our committees can operate on the same administrative basis. This group is also preparing an effective set of instructions for our conference speakers.

Each committee has defined the scope of its activities and has developed a fine program. Our committees are always given freedom in the selection and technical execution of their projects.

We have stressed continuity of leadership and have recommended that each committee have a chairman and a vice-chairman. This precludes a dead spot in committee work in case either officer must resign. Each vice-chairman is now responsible for a number of specific committee activities which result in his being fully qualified when he takes over as chairman.

In order to be sure that committee members are ready, willing, and able to devote a reasonable amount of time to project work, we now ask all to sign a "membership pledge" each year as a statement of good intent. "Deadwood" can be a major detriment to committee operation.

We have encouraged our committees to have one, or more, interim meetings during the year where they can conduct project work without the pressure of conference activities which exist at meetings such as this.

The Engineering Division has recently initiated in *Tappi* a "Question and Answer Column" in which all of you should participate. You are invited to submit questions; and we will be happy to have you answer any questions on matters with which you have knowledge and experience. It is our hope that this Question and Answer Column will become self-sustaining; however this can occur only with your active participation. Particularly interesting questions, for which no satisfactory answers are forthcoming, will serve as excellent subjects for future committee projects.

From the standpoint of financial support for project work, funds have always been and will

MURCO

TRUNNION MOUNTED, MACHINE WELDED, PLATE TYPE

BARKING DRUM

Get clean, "broom" free wood at lower cost from these features:

★ SHELL IS SHIPPED COMPLETELY ASSEMBLED. Erection time is held to a minimum.

★ SEPARATE DRIVE FOR EACH SECTION. Each section driven through motor, coupling and reducer. Foundation costs are low.

★ MACHINE WELDED SHELL. Submerged arc process operated at 750 amps assures deep penetration and absolute fusing yet imparts little strain or stress to the shell. Machine Welding eliminates hand weld imperfections.

★ SHELL IS HEAVY, ROLLED PLATE. Scallop rings or angle tumblers are welded inside to obtain proper barking action.

★ DOUBLE TRUNNION WHEELS. Two wheels, cradle mounted distribute load evenly. Perfect alignment minimizes tire and wheel wear.

WELDED IN OUR FACTORY . . . NOT IN THE FIELD

6 SIZES

10' dia.	x 30'	long.
12' dia.	x 30'	long.
12' dia.	x 45'	long.
12' dia.	x 67½'	long.
15' dia.	x 45'	long.
15' dia.	x 67½'	long.

WRITE FOR DETAILS: Engineering recommendations and proposals covering your requirements will be sent upon request.

D. J. MURRAY MANUFACTURING CO.
Manufacturers Since 1883 WAUSAU • WISCONSIN

AMERICAN (DISC-TYPE) SAVEALLS *at Scott Paper Co., Everett, Washington,*

handle 8,000 gpm of white water—show excellent recovery . . .

only 0.5 lbs. fiber/1000 gpm remains in effluent

Four American Savealls, each 9 ft. diameter with 10 discs, are installed in the Scott Paper Company mill at Everett, Washington. With only 8 of the 10 discs in operation in each machine, a total of 8,000 gpm is handled. The experience of Scott Paper Co. shows excellent recovery . . . only 0.5 lbs. fibre per 1000 gallons of clarified water.

The American Disc-Type Saveall is available in two sizes—9 ft. dia. with a maximum of 12 discs having 1320 sq. ft. filter area requires only 23 ft. x 12 ft. floor space, and 7 ft. dia. with a maximum of 8 discs and 560 sq. ft. filter area requires 8½ ft. x 15½ ft.

Outstanding operating advantages include—large filter area and high capacity with minimum floor space, easy and quick replacement of disc sectors, and fully automatic and continuous operation.

For more information on the American Disc-Type Saveall write for Bulletin 701-R. Dorr-Oliver Incorporated, Stamford, Connecticut, U.S.A.

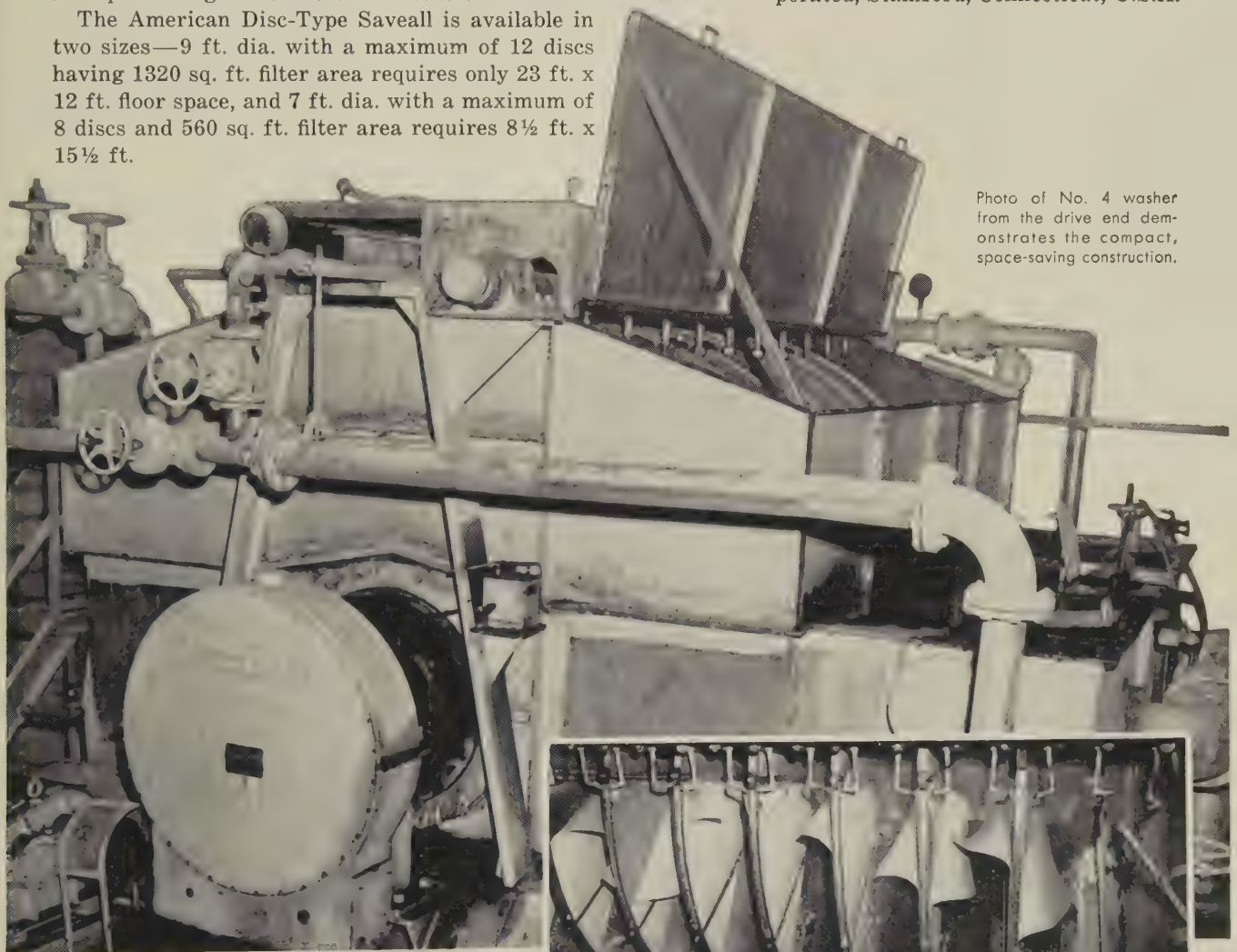

Photo of No. 4 washer from the drive end demonstrates the compact, space-saving construction.

Close-up shows how the sluicing jets cut under the sheets and peel or slice them off. The fine fibers and costly fillers are then returned to the stock chest with the sheet.

DORR-OLIVER

WORLD-WIDE RESEARCH • ENGINEERING • EQUIPMENT

STOP letting profits foam and bubble away!

AHCO PRODUCTS

Apply the sure control of Ahco Defoamers wherever the problem appears in pulp and paper making.

Among the extensive range of Ahco Defoamers there is one which applies to your particular foam problem — in the papermaking process or on the paper coating machine.

Our chemists, well aware that each and every problem of foam control has its peculiarities, are equipped to investigate and help solve yours on the spot!

ASK FOR BULLETIN 2003 ON AHCO DEFOAMERS

Talk To An Arnold, Hoffman Representative:

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ATLANTA . . . . . 3219 CAIN'S HILL PLACE
CHARLOTTE . . . . . 2130 NORTH TRYON STREET

Quality AHCO PRODUCTS Integrity

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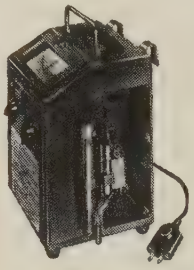
CAMBRIDGE

CONTINUOUS

pH RECORDER

This instrument provides a continuous record of pH in aqueous solutions. Because of its accuracy and dependability, it is extensively used in paper making.



CAMBRIDGE

DIRECT READING

pH METER

This portable, indicating instrument is especially designed and ruggedly built for plant use. Operating directly from line power, it is so simple to use that unskilled workers can and will use it. Of particular value in processing Pulp, Applying Sizing and Reducing Corrosion of Pipes, Fittings and Equipment.

Send for Descriptive Literature

CAMBRIDGE INSTRUMENT CO., INC.

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PIONEER MANUFACTURERS OF PRECISION INSTRUMENTS

continue to be, made available for sound, well-prepared, and well-administered projects.

Specifically we invite each of you to give a little more of yourself to TAPPI. You can:

1. Make yourself available to one of our 14 committees for project work. Any of our committee chairmen or our staff officers will be pleased to meet you and learn of your interests.
2. Submit papers for publication or for conference presentation.
3. Participate actively in the discussion of our conference papers.
4. Recommend subjects suitable for TAPPI research and Committee project activity.
5. Recommend people from your company for committee project work or for conference papers.
6. Participate in the Question and Answer Column in *Tappi*.
7. Offer constructive criticism of the Engineering Division of TAPPI.

The old adage about "leading the horse to water" certainly applies to TAPPI. We have defined the challenge; we have outlined our program; and we have invited your active participation. In such a volunteer organization we cannot "force you to drink." However I am sure that in the audience today the "leaders" far outnumber the "followers." I am equally confident that those interested in leading will recognize the opportunities and the assistance TAPPI offers its members to meet the challenge of more effective technical leadership. This group will invest of its time and energy to build a stronger future for itself and for the industry. Are you one of them?

Presented at the Fourteenth Conference of the Technical Association of the Pulp and Paper Industry, Pittsburgh, Pa., Oct. 11–15, 1959.

Which of these 3 products and services can you use from BECCO?

New Cold Caustic Bleach Process

Looking for a way to use greater amounts of low-cost, more plentiful pulp—without capital investment for bleach equipment? Then let a Becco Sales Engineer show you our new technique* which allows you to bleach in the same equipment regularly used for the manufacture of cold caustic pulp.

In this new process, peroxide bleach liquor is added at the Bauer Refiner, and bleaching occurs during the refining operation. Bleach response depends on refiner densities.

Up to 20 points brightness increase has been obtained in commercial operations to date, and with no additional steam costs, no holding time, and no excessive chemical costs.

Becco can assist you immediately in setting up a production run and evaluating results. First step: use the coupon to let us know you're interested.

*—Patent Pending

BECCO fmc

BECCO CHEMICAL DIVISION, FMC
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Dept. T-H

Gentlemen:
Please have a Sales Engineer give me more information on Becco's Cold Caustic Bleach Process.

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TECHNICAL BULLETINS

We got 'em—
You can have 'em!
They're FREE!

Years of experience in paper and pulp processing have produced a library of technical information which is available in individual bulletins, free on request. Use the coupon below to let us know which you'd like to receive.

No. 31 — Groundwood Bleaching Variables — A Statistical Approach.

No. 32 — H_2O_2 Bleaching of Chemicals and Mechanical Pulps.

No. 47 — Peroxide Bleaching of Pulps.

No. 48 — High-Density Pulp Bleaching.

No. 64 — Development Studies on Last-Stage H_2O_2 Bleaching of Alkaline Pulps.

No. 65 — Peroxide Bleaching of Southern Pulps.

No. 66 — Becco Laboratory Procedures for Pulp Bleaching, 1955 Ed.

No. 91 — Peroxide Bleaching of Chemi-Mechanical Hardwood Pulps.

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BECCO fmc

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Gentlemen:
Please send me a copy of each of the following bulletins:

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Problems in handling Hydrogen Peroxide

?

Becco's Four-Fold Engineering Service Program—offered free—includes:

1. Comprehensive survey of your facilities.
2. Specific proposal with recommendation of proved equipment and where it is obtainable.
3. Installation supervision by Becco.
4. Periodic inspection and permanent service.

Can you use this free Becco help, based on more years of experience with bulk handling of H_2O_2 than any other manufacturer? Use the coupon to let us know.

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Gentlemen:
Please tell me more about your Four-Fold Engineering Service.

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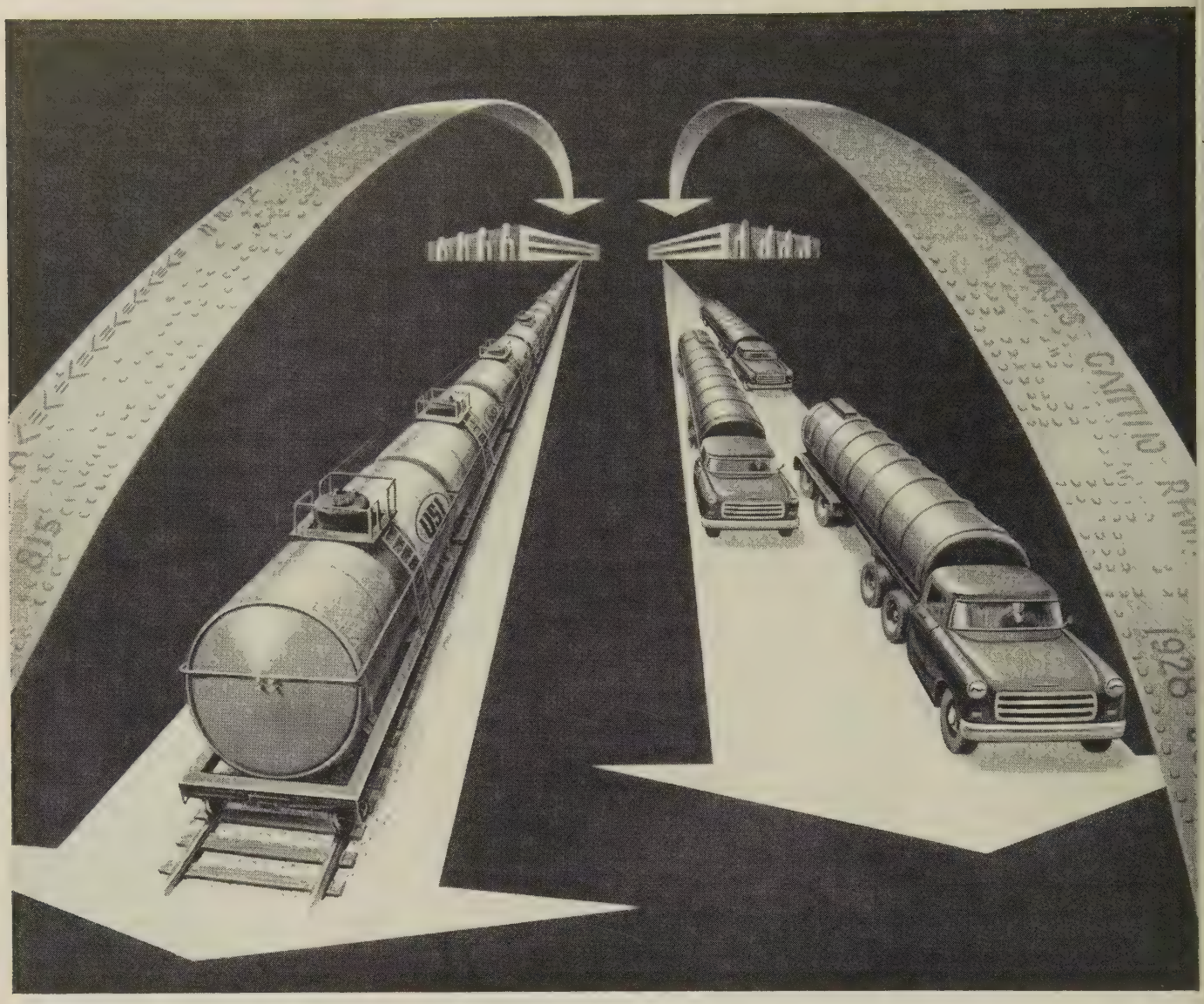

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. . . from Huntsville, Alabama

To U.S.I., customers' orders are high priority communications. That's why our offices and plants all over the country are linked in a 7,000-mile private wire network of teletypes and data processing equipment.

As one of U.S.I.'s customers for chlorine or caustic soda, here is the way this automated order handling system would insure quick delivery of *your* shipment. When your order is placed with the U.S.I. sales office in your area, it is transmitted by coded tape direct to Huntsville, Ala. Here automatic machines use the tape to produce shipping papers, invoice and such records as are needed for internal use. The system cuts as much as four days from the time that might be required to process your order by ordinary methods.

Ample capacity at U.S.I.'s two Huntsville plants is further assurance of expedited service.

Liquid chlorine is shipped from Huntsville in tank cars, commercial grade 50% liquid caustic soda in tank cars, tank trucks and barges. Other U.S.I. plants supply ammonia, polyethylene and sodium peroxide. Make U.S.I. *your* supplier of these paper chemicals. Our products and ability to serve you are discussed in the booklet "National Distillers and Chemical Corporation Expands in the Chemical Industry". We'll be happy to send you a copy.

U.S. Industrial Chemicals Co.
99 Park Avenue, New York 16, N. Y.
We'd like to know more about U.S.I.

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- ☐ Send information on your Automated Order Handling System
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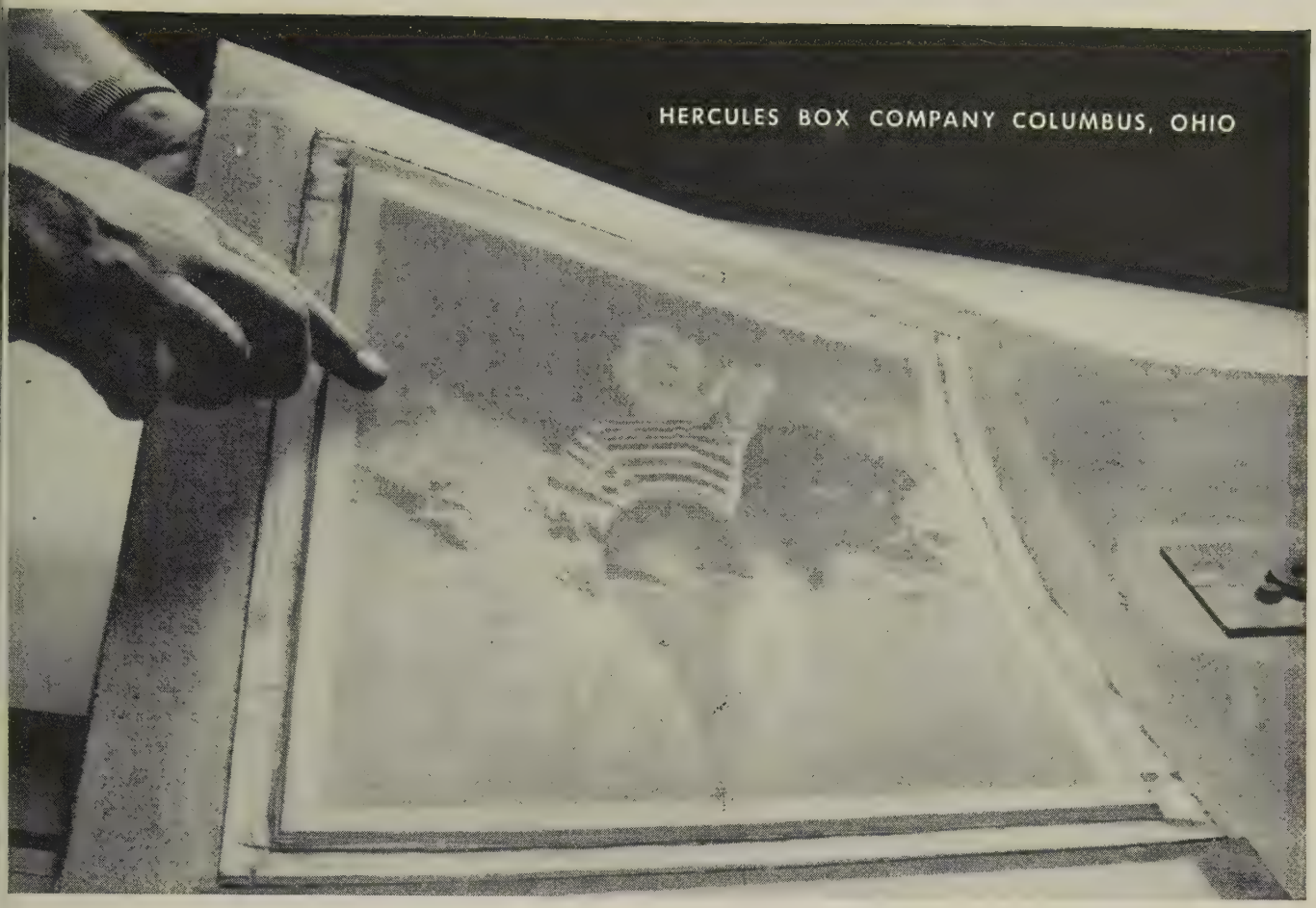


Uses halftones for printing, Cities Service Wax for coating

Tired of being restricted to line art on corrugated? So was Hercules Box Company—and despite the skeptics, Hercules did something about it.

Today, thanks to a special plastic die developed by Hercules it is possible to print halftone photographs on corrugated!

Creative thinking such as this dominates all that is planned or purchased at Hercules . . . and is clearly reflected in their choice of Cities Service Pacemaker Wax.

Cities Service won the wax role at Hercules because in its own way it is as far ahead of competition as Hercules itself.

Locally warehoused, and delivered in palletized packages from 54 pounds to one ton, Cities Service Pacemaker Wax enables lower wax inventory, frees valuable storage space.

Moreover, the quality of Pacemaker Wax cannot be surpassed. Made in the world's most modern wax refinery and subjected to the most exhaustive testing in the industry, Pacemaker gives maximum resistance to blocking and moisture transmission, has excellent tensile strength, hardness, gloss, and gloss retention.

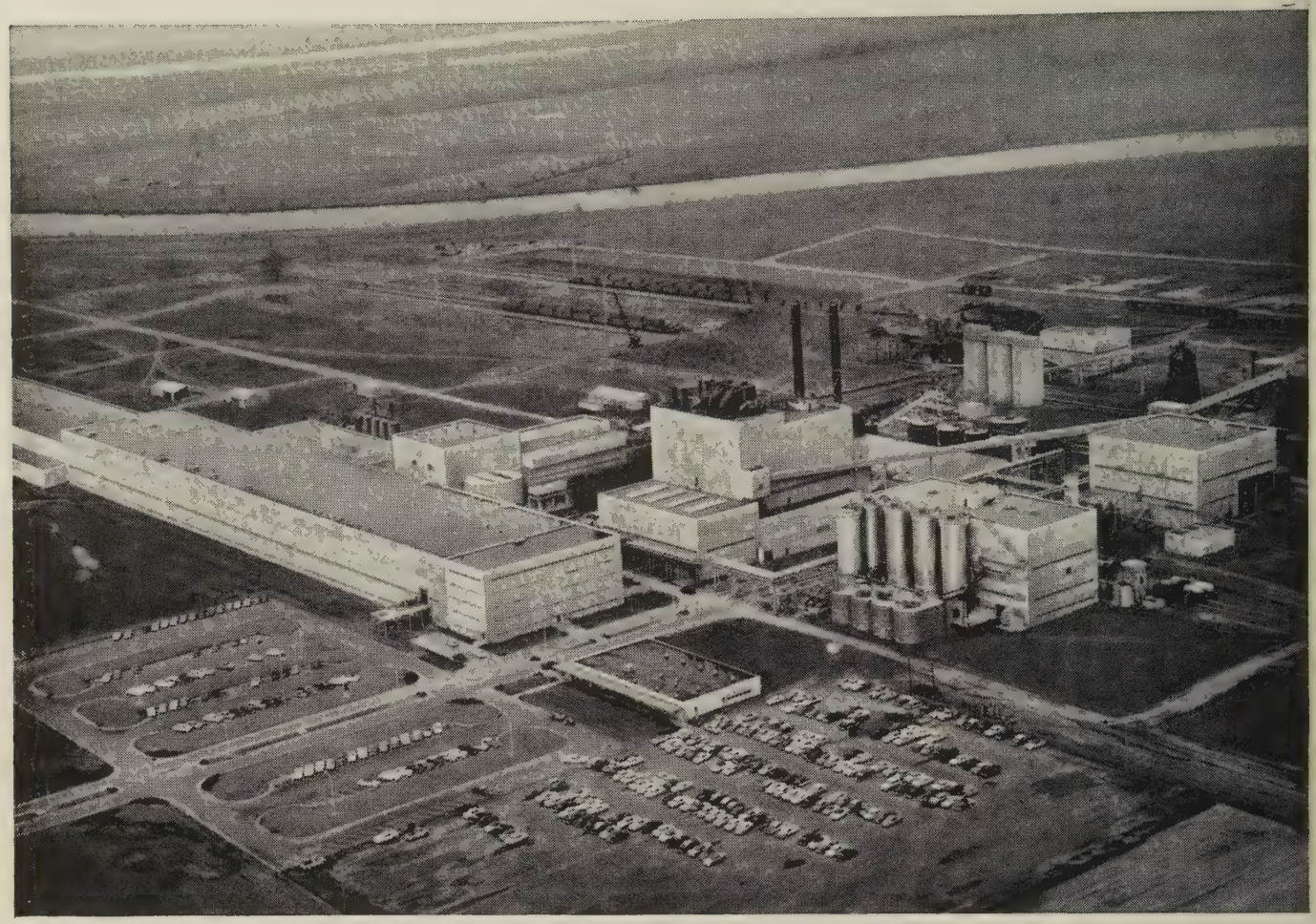
If you're looking for that rare combination of superb quality and swift service, talk with a Cities Service Wax Representative. Call the nearest office or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, New York.

Typical Example of the results Hercules achieves with its halftone printing process is this corrugated box for dishware. Hercules also pioneered use of fast drying water based inks.

A More Efficient Waxing Operation is achieved with Cities Service Pacemaker. The wax prevents blocking, gives hard gloss and maximum resistance to moisture transmission. Locally warehoused, it enables quick delivery and less storage for customers.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



B&W High Pressure, High Temperature Boilers for International Paper

Two Recovery, Two Power Units Now on Stream at Pine Bluff, Arkansas Mill

This is International Paper Company's new bleached board and newsprint mill near Pine Bluff, Arkansas. The 60,000 kw power demand, process steam requirements, plus rising fuel costs prompted the selection of high pressure, high temperature steam generating equipment.

Four B&W Boilers—two power and two recovery units—supply steam at the rate of 1,300,000 pounds per hour. The Cyclone Furnace fired power boilers burn bark, oil, coal, or natural gas alone or in combination. Each generates 450,000 pounds of steam per hour at 1275 psi and 1000 F. The recovery units are designed to process 1,170,000 pounds of black liquor solids per day and produce 202,000 pounds of steam per hour at 1275 psi and 900 F. For efficient heat recovery, they're equipped with economizers, tubular air heaters, and Venturi Evaporator-Scrubbers which reduce exit gas temperatures to 200 F.

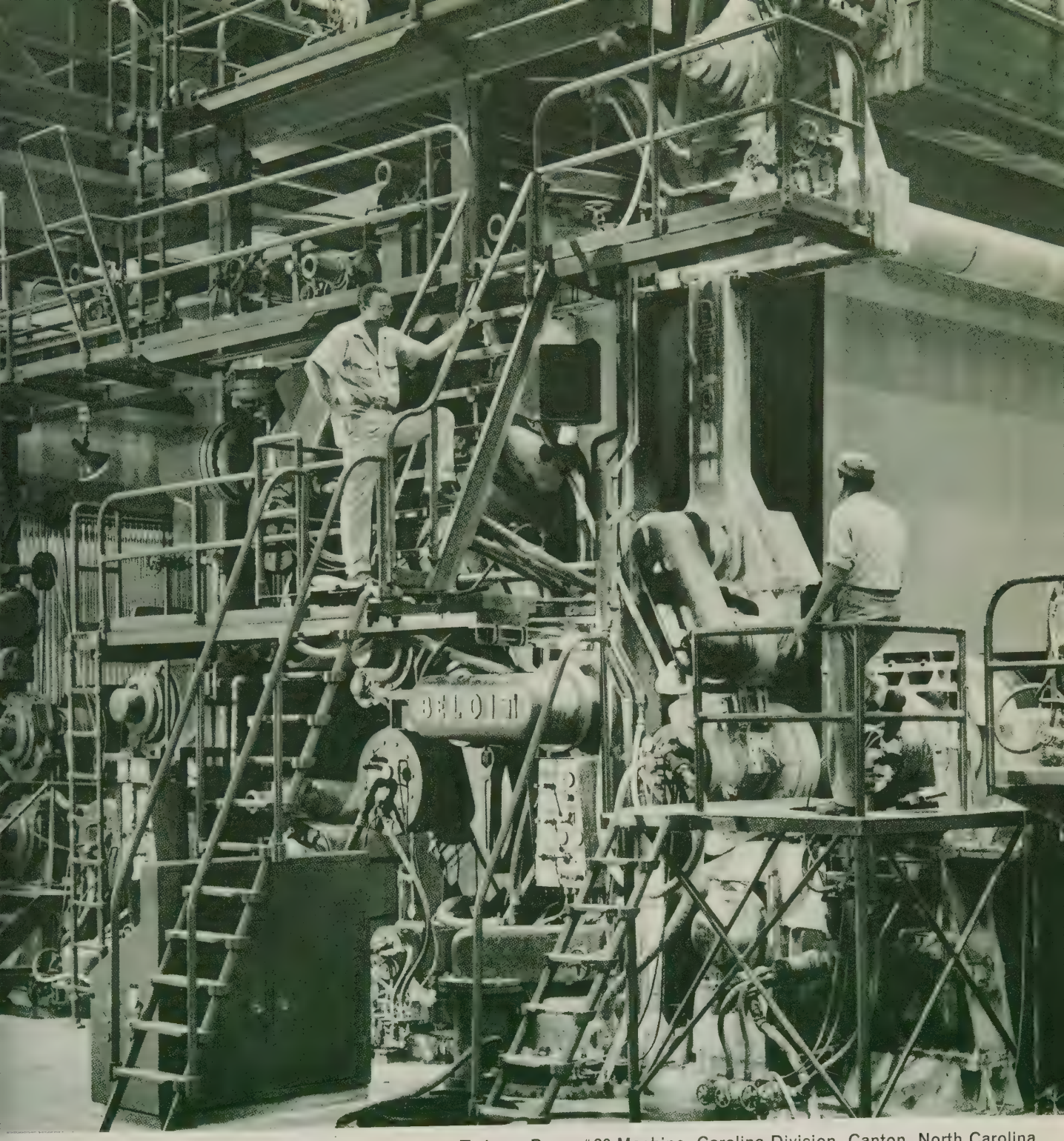
Pine Bluff's steam generating system is another example of B&W's ability to meet the rapidly increasing steam demands of the Pulp and Paper Industry. If you're thinking of building a new mill or expanding an old one, we can provide the economical solution to your steam generation and chemical recovery problems. Just write to the Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

P-820

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

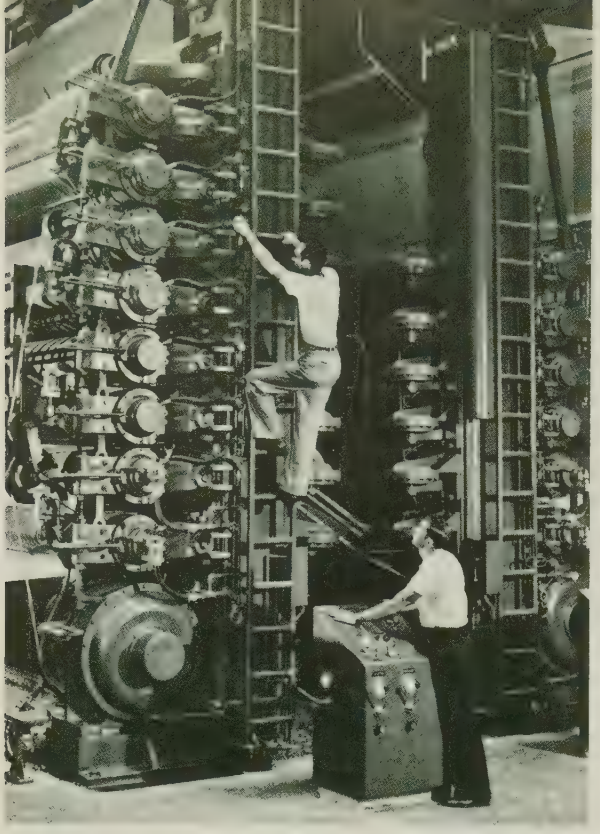


R. CHRISTENSEN

Twinver Press #20 Machine, Carolina Division, Canton, North Carolina

The Champion Paper and Fibre Company

Champion's new number 20 machine at Canton, North Carolina, "sets the pace in fine papermaking." This 246″ fine papers machine is the largest, most productive machine of its type in the world. Its successful startup marks another milestone in Champion's continuing expansion of productive capacity. For further details, please turn page.



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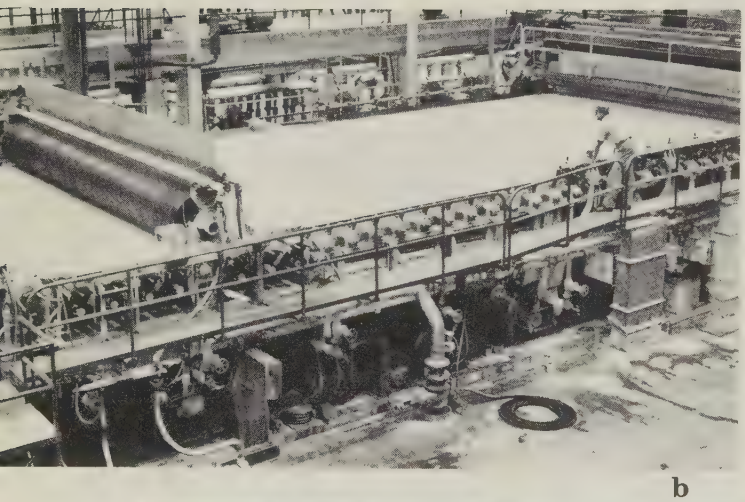
. . . some features of Champion's new Beloit 246″ fine papers machine pictured on the preceding page

Number 20 machine adds 90,000 tons of annual production to The Champion Paper and Fibre Company's fine papers line. The machine is designed to operate in the 2,000 fpm range. The surrounding photos show some features of the machine. **(a)** Twin open side calender stacks with nip relief arrangement; **(b)** removable Fourdrinier; **(c)** finished roll conveyor and roll breaker arrangement; **(d)** high-speed pneumatic reel; **(e)** Beloit model "L" winder, oscillating unwind stand, roll and shaft handling equipment; **(f)** Beloit differential drive unit at wire turning roll position.



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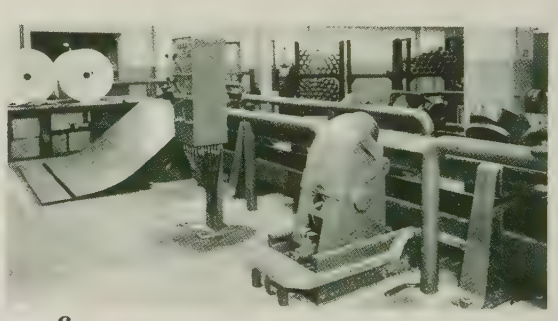

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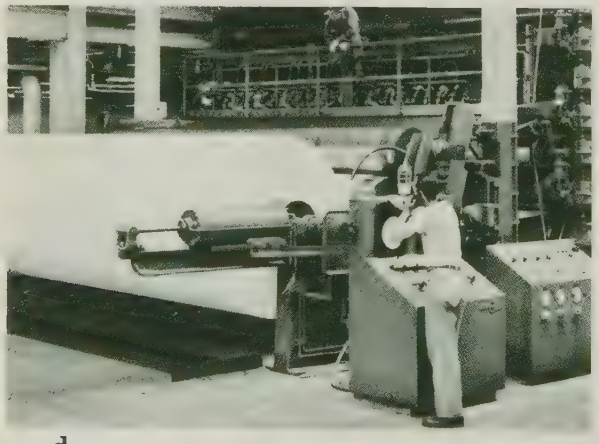

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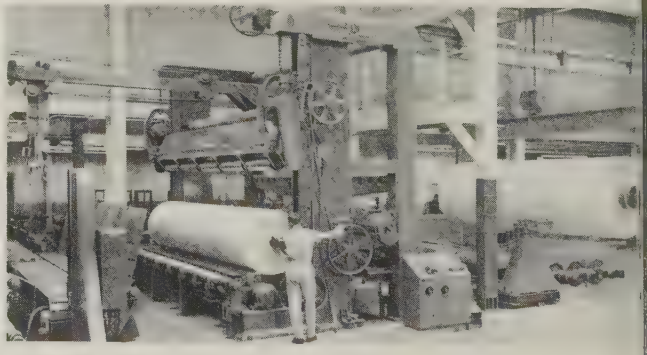

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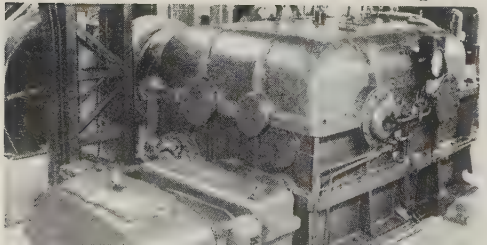

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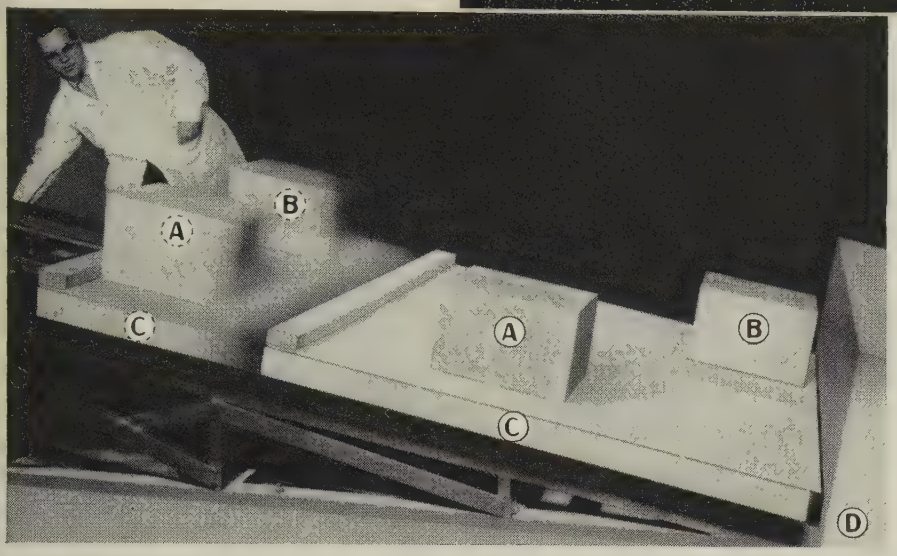
BETTER THINGS FOR BETTER LIVING... THROUGH CHEMISTRY

chemical briefs

FOR THE PAPER INDUSTRY



SLIP RESISTANCE of boxboard containers is measured by Conbur Impact Tester which simulates impacts received by packages during shipping. Carton treated with "Ludox" (A) is placed on treated kraft paper, which covers one half the surface of the sliding inclined plane (C). Untreated carton (B) is placed on untreated kraft paper. The inclined plane is released, striking stop (D) with an impact equivalent to a dead stop at 6 mph. Repeated tests show treated cartons slide only ⅛ as far as untreated cartons.

DU PONT ENGINEERING TESTS PROVE...

Anti-slip coatings of Du Pont LUDOX® reduce slippage of corrugated cartons by 67%

Losses due to damage in handling and shipping greatly reduced

Invisible coatings of Du Pont "Ludox" colloidal silica on corrugated cartons can mean the difference between safe shipment and costly damage. Using the Conbur Impact Tester (above) the Du Pont Engineering Test Center simulated impacts received by packaged products during shipping. Result: Cartons treated with "Ludox" slip 60 to 70% less than untreated containers!

This fact is important since Du Pont experience shows that 75% of all damage to one-trip fiberboard cartons results from impacts received during coupling and normal starts and stops in rail shipment.

What this means to package users

There's less damage to packaged products because of (1) reduced movement of treated packages in rail and truck shipment, and (2) greater stability of carton loads during in-plant handling. Treated packages stack solidly with less danger to personnel. And the expense of repackaging due to damage is reduced.

Coatings of "Ludox" can be applied to finished packages or to paper products by mills or converters. Treated packages resist soiling, permit sharper printing . . . increasing customer appeal of finished packages.

Names of suppliers of treated packages and more information about "Ludox" are available on request. Just fill out and mail coupon below.

New Du Pont program offers tailor-made adhesives for paper laminates

When special adhesives are needed for strong paper-to-paper bonds, or where equipment calls for particular formulations... chances are Du Pont can tailor-make a Weatherproof Adhesive to fill the bill.

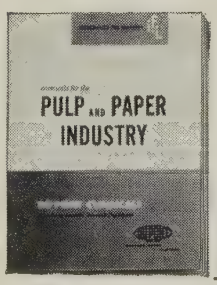
Manufacturers of laminated paper products are invited to take advantage of special Du Pont facilities which are available for solving adhesive problems and for compounding adhesives suited to difficult product requirements. The coupon will bring further information.

CHEMICALS BASIC TO THE PAPER INDUSTRY

In addition to a group of specialty chemicals that offer unique benefits to end products, the Du Pont Industrial and Biochemicals Dept. also supplies the following basic chemicals to the pulp and paper industry:

Aluminum Chloride Solution	Reagent Acids and Ammonia
Aluminum Sulfate	Salt Cake
Ammonium Sulfamate	Sodium Carbonate
Aqua Ammonia	Sodium Phosphate – Di
Caustic Soda	Sodium Tripolyphosphate
Copper Sulfate	Sodium Pyrophosphate
Diatomaceous Earth	Sodium Silicate
"Lignasan" X Fungicide	Sodium Sulfite
Mineral Adhesive Solution	Sodium Thiosulfate
	Sulfamic Acid
	Zinc Chloride

MAIL COUPON for your copy of "Chemicals for the Pulp and Paper Industry," which describes the benefits made possible by Du Pont Chemicals. Perhaps you'll find new ways to improve product quality, build sales appeal. E. I. du Pont de Nemours & Co. (Inc.), Industrial and Biochemicals Dept., Room N-2533, Wilmington 98, Delaware.



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Wilmington 98, Delaware

Please send me a copy of "Chemicals for the Pulp and Paper Industry" and more information about: ☐ Anti-slip coatings of "Ludox"; ☐ Tailor-made Weatherproof Adhesives.

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Research, Productivity, and Resources

JOHN G. STRANGE

I HAVE been much impressed by the size and quality of the registration for this symposium on fiber attraction and bonding. It is apparent that the responsible committees have chosen a subject of broad interest, and it has been a very real privilege for the Institute to provide a site for your meetings. We hope that you have been reasonably comfortable and that our facilities have been adequate for your purposes.

You have been extremely busy during the past two and a half days, and I do not propose to test your endurance further by making a long speech at this time. There are, however, a few thoughts which have come to my mind, and I would like to share them briefly with you.

We might first consider the reasons which have caused you to attend a meeting of this kind. Why are you here at all, and what do you expect to gain as a result of your participation? The most pragmatic answer, of course, is that you hope that a better understanding of fiber bonding will advance industry technology and improve the efficiency and versatility of your products. I suspect, however, that there are several other motivating factors, and these would range all the way from a genuine curiosity about the fundamental behavior of materials to the less profound but quite reasonable desire to circulate and share experiences in a technical fraternity. In a broader sense, this meeting, in common with the hundreds of other seminars and symposia which have been held throughout the country this summer, is a manifestation of our current preoccupation with science and with research and development.

As most of you know, this country is now spending over 9 billion dollars annually on its various research endeavor. This is roughly ten times as much as we spent less than 20 years ago, and over 60% of our effort is financed directly or indirectly by government funds. Thus, if we may regard the many different research and development programs as a single enterprise, it is apparent that they represent the most rapidly growing and most highly socialized segment of our economy.

Now it is obvious that our intensified concern with research has been only partly stimulated by curiosity about ourselves and our environment, or by the humanitarian desire to alleviate poverty, disease, and ignorance, or by commercial competition. Overriding all of these driving forces is the proposition of our national security and continuity at a time when they seem to be actively threatened by an antithetical and virulent political system.

There is no point in dwelling on this situation, important as it may be. I am quite sure that we will continue to flex our "scientific muscles" on an international scale for many years to come, but I am also confident that when the political tensions are finally resolved there will be no sustained cutback in our collective scientific effort, although the emphasis will, of course be shifted. My reason for feeling this way goes beyond the fact that science has become deeply embedded in our culture and that it tends to build on itself. The political pressures for discovery and invention will be more than replaced by social and economic pressures, and these pressures will, in turn, be fortified by a growing acceptance of the ethic of conservation. With this in mind, we might examine for a moment the nature of some of these socio-economic pressures and the substance of what I have called "the ethic of conservation."

A great deal has been said and written about the tremendous surge in population which is taking place throughout the world. Only 5 years ago, at one of our Executives' Conferences, we tried to predict the size and character of the paper industry 25 years hence, or in 1975. It was necessary for us to postulate a national population for that future year, and after reviewing various demographic studies, we chose a figure of 200 million. It now appears that there will be at least 25 million more than that number, and there are some who make the seemingly fantastic prediction that our current world population will be doubled by the year 2000, or within the lifetime of our children. When one translates this arithmetic into raw material, space and energy requirements, he finds a tremendous and almost overwhelming challenge for science and technology. This, however, is merely the quantitative side. Of more immediate concern to those of us who are in this room is the particular distribution of our population among various economic and social pursuits and the fact that we are well into an age of high mass consumption and are thus confronted with political, sociological, managerial, and professional problems which have no historical precedent.

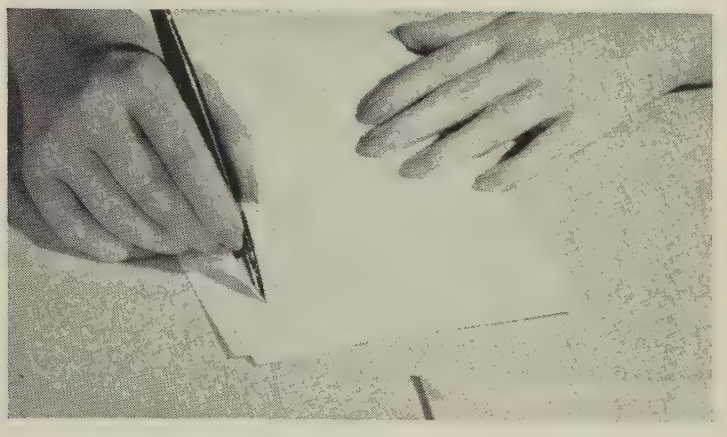
In a recent series of lectures at Cambridge University, Professor Rostow spoke of pre-Newtonian and post-Newtonian societies. He used Newton as a symbol of "that watershed in history when men came to believe that the external world was subject to knowable laws and capable of productive manipulation." In a typical pre-Newtonian society more than 75% of the working force was engaged in the production of food alone. Today only 14% of our working force is so engaged, but there is much more to the story than this.

A year or so ago, for the first time, statistics disclosed that if we combine those who work in agriculture with those who are employed in manufacturing industries, the total is less than half of our working population! Or, putting it conversely, more than 50% of our working force is concerned with services of one kind or another. This figure becomes even more remarkable when one realizes that only 36% of our total population is at

JOHN G. STRANGE, President, The Institute of Paper Chemistry, Appleton, Wis.

No. 1 Requirement: Quality

Here's How a Mill Kept It... And Saved $.95 per Paper Ton!



Cash savings on size requirements multiplied by power savings, cleaner machines, better retention

Fine writing paper production can not take process short-cuts which affect quality . . . so this instance of Nalco Sodium Aluminate performance is more than a cost-cutting story—sheet specifications were considerably improved with Nalco 680 Sodium Aluminate—on top of all the other advantages!

Facts from Figures

This is the way the chemical costs work out on a "per ton" basis:

Size Requirements (without Nalco Sodium Aluminate)...	30.25 lb.
Size Requirements (with Nalco Sodium Aluminate)...	21.60 lb.
Pounds of Size Saved...	8.65
Alum Requirements (without Nalco Sodium Aluminate)...	40.00 lb.
Alum Requirements (with Nalco Sodium Aluminate)...	30.00 lb.
Pounds of Alum Saved...	10.00
Savings on Size (at 15.3 cents per lb.)...	$ 1.32
Savings on Alum (at 2.2 cents per lb.)...	.22
	$ 1.54
Less cost of Nalco Sodium Aluminate (at 10.7 cents per lb.)...	.59
TOTAL NET SAVING, per ton of paper	**$ .95**

Add to the dollar savings above: more fines and furnish kept in the sheet; more rapid reaction time to cut soluble alumina losses in the white water; higher pH to give means of adjusting size-alumina-pH ratio, and to cut corrosion damage; lower power requirements and cleaner machines.

Nalco Sodium Aluminate is a concentrated package of stable, soluble alumina and alkalinity that produces positive advantages all along the line!

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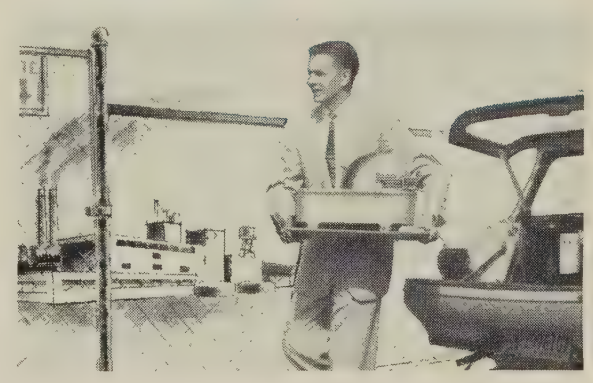
Nalco Sodium Aluminate not only produces spectacular figures in processing savings, but also improved sheet specifications in the mill whose alum-aluminate costs are given above: *Size ratings jumped from a range of 45-50 up to 50-60. Ash content went from 5.6-5.8% to 7-7.1%!*

Other quality improvements include: better aging, folding endurance, burst strength, workability and reduced brittleness.

Action When It Is Needed



Results with Nalco Sodium Aluminate—and every other Nalco chemical used in paper processing—are backed by Nalco Field Service Men whose experience and willingness to help can be of real value to you . . . whether the situation calls for emergency action or long-range planning for better paper products at lowest possible production costs.

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"I've chipped off all the rust, Chief, but don't the walls seem kind of thin?"

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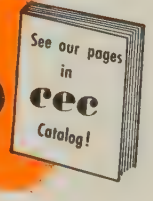


work. Of the balance, roughly 34 million are keeping house (or supposedly doing so); 19 million are of preschool age; over 46 million are going to school, and around 14 million are retired. Now, I am sure that most housewives and students would object furiously to the idea that they are not a part of the working force, and in one sense they might be right! We are concerned here, however, with the "logistics" of our modern society and with the astonishing fact that all of our raw materials, food, clothing, and manufactured products are actually produced by only 18% of the people—and this on a 40-hr. week!

This amazing division of labor and distribution of vocational pursuits is, of course, a direct reflection of our advances in science and technology. Certainly we are enjoying a greater abundance than any previous society, and we are doing so with proportionately less effort. Accompanying this abundance, however, have been some very puzzling problems of social organization, economic interpretation, and individual orientation. Most obvious and most frequently discussed, is the specialization of occupations and the highly sensitive interdependence of our population. The average person is more competent in certain ways than his ancestors, but he is also much less viable as an economic unit. The concept of the "rugged individual has been undermined, and growing emphasis has accordingly been placed on various welfare and security measures.

Less obvious than the tendency of the individual to seek collective security, but perhaps more alarming as both a present and longer range threat, is the fact that our division of labor, with its dwindling percentage of those who are engaged in manufacturing or agriculture, is forming an "economic geometry," if we may use that expression, which is increasingly sensitive to inflationary leverage. Pressures applied at a given point in the economy manifest themselves quite rapidly throughout the system and are not easily absorbed or accommodated by the majority of the population which is either performing services, or is not a part of the working force.

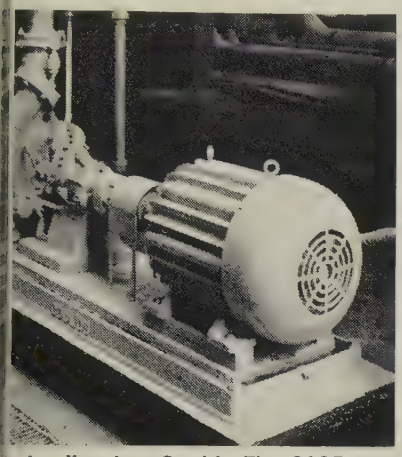
larathon Southern Corporation's all-new mill uses over 00 Goulds pumps to do a wide variety of pumping jobs—umping everything from mill water to liquors and stock.

Look over these Goulds installations at Marathon Southrn's new facilities in Naheola, Ala. See the diverse services loulds pumps provide—at pumping rates that range from 5 to 15,000 GPM. Goulds offers a choice of many different ypes of pumps for every job, as well as a wide range of naterials of construction.

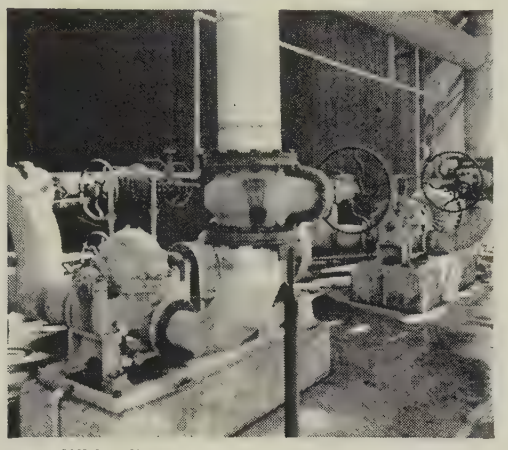
To select the right pump for *your* job—whether it be in igester plant, stock plant, bleach or paper mill—talk to a loulds representative. You can get in touch by writing to loulds Pumps, Inc., Dept. TA-109, Seneca Falls, N. Y.

GOULDS PUMPS

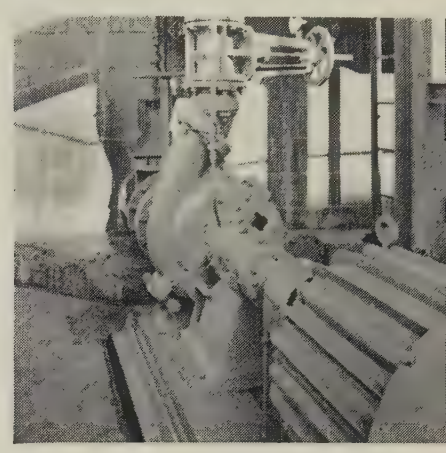
Mill water supply. Three Goulds Fig. 3450 pumps provide 10,000 GPM each, heads of 125 ft.



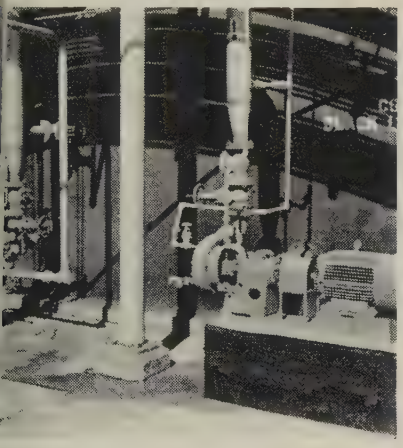
s to digester. Goulds Fig. 3135 les black liquor and knots at F, 500 GPM, head of 90 ft.



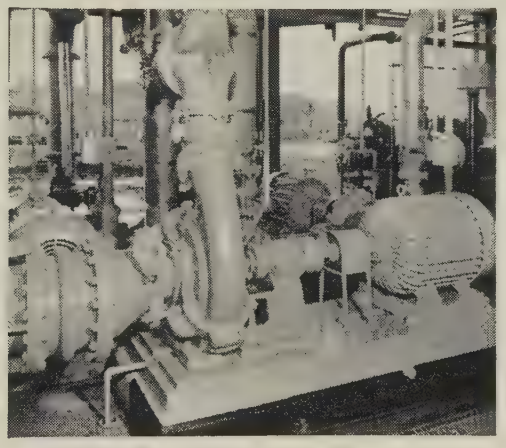
White liquor to measuring tank. Two Goulds Fig. 3405 pumps move white liquor at 1000 GPM each to a head of 100 ft. No. 316 SS construction.



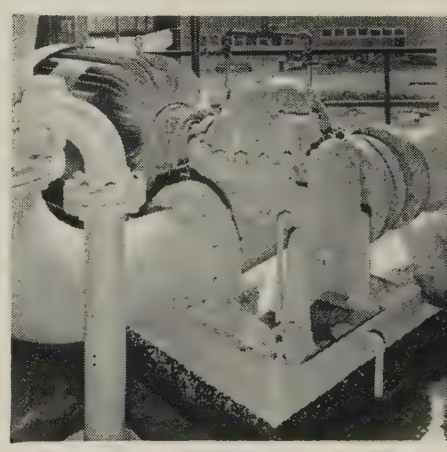
Stock to stock-preparation room. A Goulds Fig. 3135 moves 4% stock at a rate of 1600 GPM, head of 70 ft.



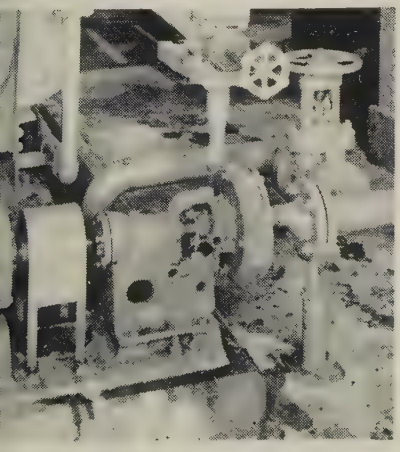
k liquor to recovery. Two Goulds 5 pumps handle black liquor at GPM each to a head of 65 feet. 316 SS construction.



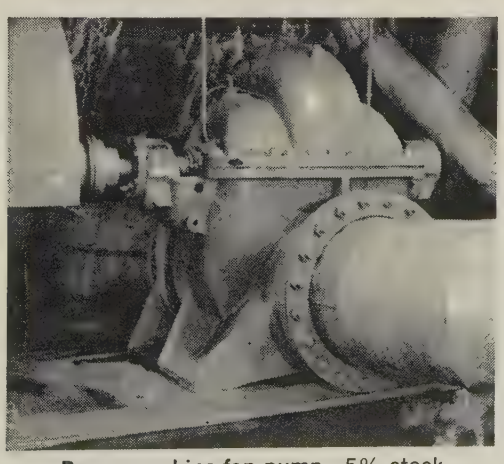
Stock to caustic washer. A Goulds 3135 moves 2½% kraft stock at 2400 GPM to a head of 68 feet.



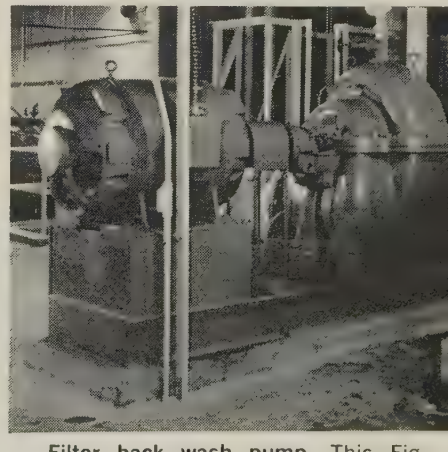
White water to chlorine washer. Goulds 3405 handles filtrate at a rate of 4500 GPM to a head of 80 ft. No. 317 SS construction.



n size emulsion. A Goulds Fig.) handles 4% rosin size emul- at 25 GPM to a head of 65 ft.



Paper machine fan pump. .5% stock moves at a rate of 15,000 GPM in this Goulds Fig. 3420. Head is 60 ft.



Filter back wash pump. This Fig. 3423 is handling water for filter back wash. 13,000 GPM. 60 ft. head.

Now there are, of course, certain countervailing forces to inflation, and one of the most important of these can be the continuing improvement of productivity, which we shall define at this point as "output per man-hour." I say that improved productivity *can* be a countervailing force because whether or not it actually is depends on wageprice movements within the area of the economy involved. Quite frequently it is suggested that wages should not rise any faster than productivity, the implication being that if the two go forward at the same pace, it is probably all right. It seems to me that this is a very questionable and perhaps even dangerous thesis. It ignores many economic facts of life, such as, the interests of the consumer and the stockholder, our capacity to participate in world trade, and above all, the central point that technology and improved tools are the largest contributor to productivity, and they must be continuously refurbished by the re-investment of funds. As one economist has said, "Capital formation is not merely a matter of maximizing profit; it is a matter of society's effective attitude toward science. . ."

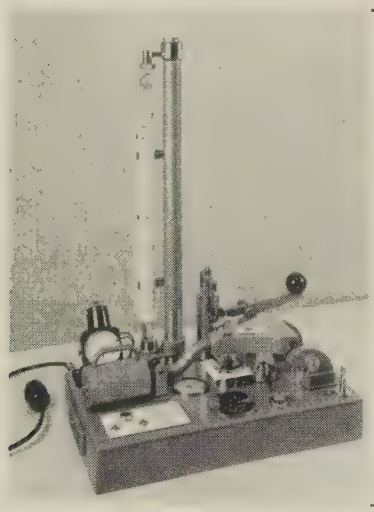
My remarks thus far have been concerned primarily with some of the socio-economic pressures which will push us into expanded research and development. I have referred, for example, to population trends and our accelerating need for raw materials, space and energy. I have spoken of our peculiar division of labor and have observed that the "economic man" is no longer as viable as he used to be. This state of affairs has led us along the path of collective security, and it has also made us more susceptible to inflationary forces. In this connection we have noted that one of the most effective ways of countering inflation is through the steady improvement of productivity, assuming that a fair share of the fruits of productivity are available for further investment in research and technology. I should like now to deal briefly with the ethic of conservation and the influence which this concept may have on scientific enterprise.

At this point it is necessary for us to reconsider our earlier definition of "productivity." You will recall that we tentatively defined productivity as output per man-hour. Actually, productivity is a great deal more than this because, in its most meaningful sense, it involves nonproduction employees as well as those who are on the production line, and more importantly, it also involves the efficiency with which we use our raw materials, energy, and other resources, including capital funds. In short, productivity is the relation of total output to total input. When we define it in this fashion it becomes a measure of our effective use of both human and natural resources, and this, it seems to me, is the essence of dynamic conservation.

I use the adjective "dynamic" because in the minds of some people conservation is still a passive philosophy involving the saving or impounding of resources in order to protect them from human utilization. Carried to its extreme, this viewpoint is not only impractical, but it also suggests a curious kind of dualism in which mankind is excluded from the so-called balance of nature. Now, it would appear that man is not only a part of the balance of nature, but he is also uniquely endowed with the capacity to improve and augment this balance, because he has the intelligence to probe its essential order and to understand its harmony. When this probing and understanding is undertaken with the ultimate objective of effective and conservative use, it becomes a matter of principle and thus has an ethical or moral basis which I would call "the ethic of conservation." For reasons which I shall not develop today it is my conviction that this concept will spread in the future, and it will become one of the principal motivating factors among scientists and within the various fields of science.

One might wonder whether the "ethic of conservation" is compatible with an individualistic society which is spurred primarily by the profit motive, or whether, the other hand, its effective pursuit requires a high degree of socialization. The answer, it seems to me, is quite clear. Governments and institutions may be guided by certain principles, but as Boris Pasternak has said, "Only individuals seek the truth." And it is through our eternal seeking of the truth that we build and expand out ethical and moral concepts. Self discipline and stewardship on a corporate scale would appear to be the answer, and I believe that we already see some rather good examples of this within our own industry.

Presented at the Symposium on Fundamentals of Fiber Attraction and Bonding sponsored by the Technical Association of the Pulp and Paper Industry held at The Institute of Paper Chemistry, Appleton, Wis., Sept. 9, 10, and 11, 1959.



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Unusual Opportunities in Paper Products

ALBERT W. DUNNING

Most of you are familiar with bakery advertisements dramatizing their product as never having been touched by human hands. Those of us working with paper and coated products are not too impressed by such ads. Our products have been produced that way for years. But here is something really new—an isometric drawing never touched by human hands during the whole process of its making (Fig. 1). A formulation was punched into a computer machine that not only solved the problem, but delivered the information in the form of this isometric drawing.

Does this mean exit, your engineering drafting room? Perhaps—at least in part. Mechanization of routine manufacturing processes has been well advanced in the last 20 years. Now the white collar areas of engineering and office operations are facing major changes through mechanization of data handling.

> "So tell me quick and tell me true,
> Or else I haven't time for you."

This little ditty headed up a serious presentation by Esso Research staff members concerning their problems of data handling and visual communications. The paper was given in Pittsburgh Jan. 20, 1958, before the American Chemical Society.

"Quick and true" typifies the tempo of all phases of communications today, yet something stronger has to be added to periodically shock us out of lethargy. The sharp needle reminder to keep ourselves alert is mindful medicine. We must realize that "quick and true" requirements of *exchanging* information might well determine our very survival in the world of competitive living ahead of us.

I am not here to give you a lengthy technical treatise on this theme. Rather I hope to bring you a concise practical picture in a selected area of new enterprise that shows promise of unusual opportunities in paper products. In preparing you for this, however, I want to relate some rather earthy experiences and thoughts from my career that have been helpful in market research work during the past year. With your permission, then, I will start by calling for audience participation.

Will someone in the audience who has a $1.00 bill come up here, please. Good! Now let me give you this $1.00 bill in exchange for yours. Seems like a silly interchange, doesn't it? Well, it really is, as nothing is gained or lost; but (Fig. 2) if I gave you an idea in exchange for one from you, we both profit because you go your way with *two* ideas and I go mine with *two* also. In fact, such an exchange might generate a third or even a fourth idea as in brain storming.

Now what really happens in such an exchange of ideas? Do I really get my idea across to you and you to me? No! At least not exactly.

Albert W. Dunning, Director of Market Research, The Plastic Coating Corp., Holyoke, Mass.

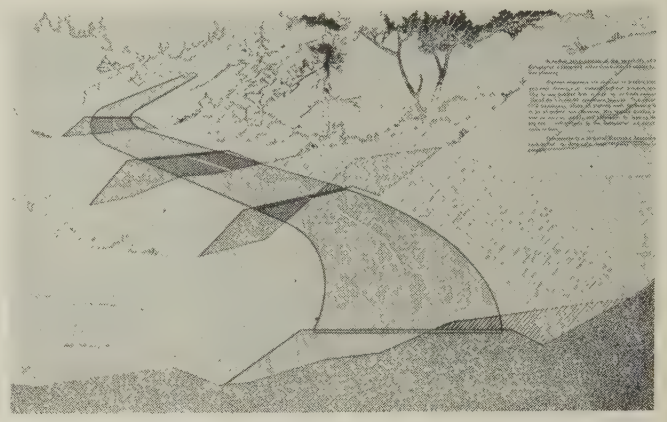


Fig. 1

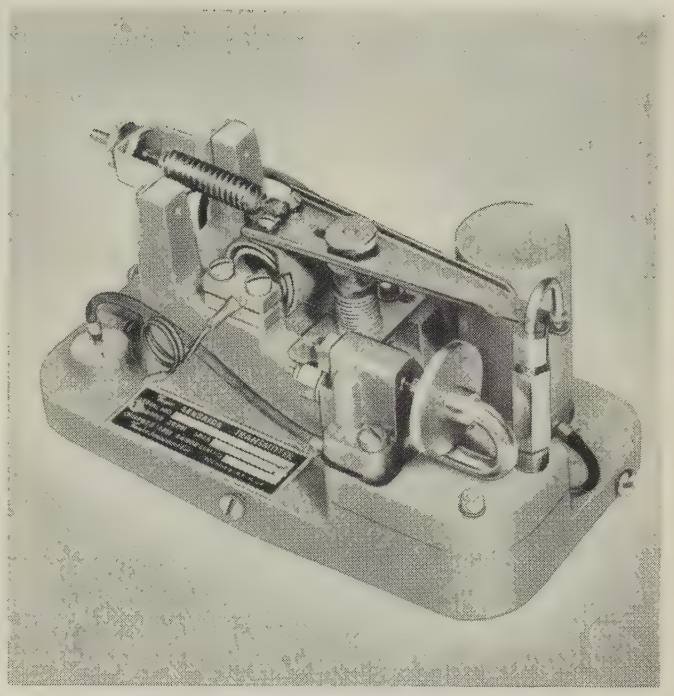
Let's project this into another illustration (Fig. 3) in color. From school days you are all familiar with the basic pigments of red, blue, and yellow and the secondary colors orange, green, and violet. Mixing of any two primaries will result in a secondary. Then if I am thinking "blue" thoughts and you are thinking "yellow" thoughts, the interchange is more likely to produce two "green" thoughts. This is because my blue thoughts are expressed in terms of my background and experience which may be quite different from yours. Further, you are mixing my blue thoughts with the conditions of your own background and experience. The result will be green.

From this analogy we can never quite get in tune with each other. How fortunate this is because it insures endless originality, the very essence of creativity and progress.

Our means of communications are quite varied. We have visual and audio methods which can be illustrated by symbolic and realistic means. They overlap, as

Fig. 2

LOW COST AND EASE OF INSTALLATION PERMIT WIDE USAGE.



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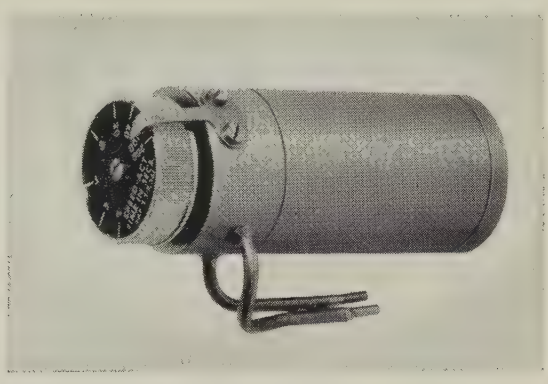

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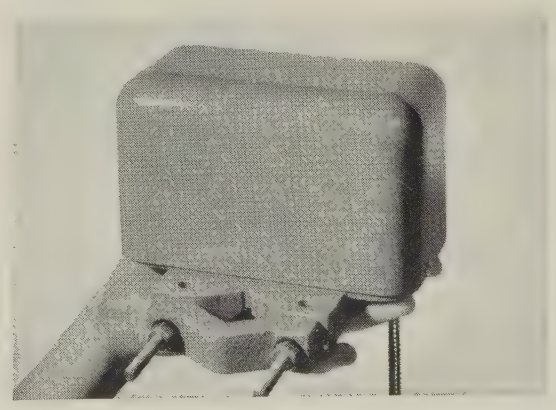

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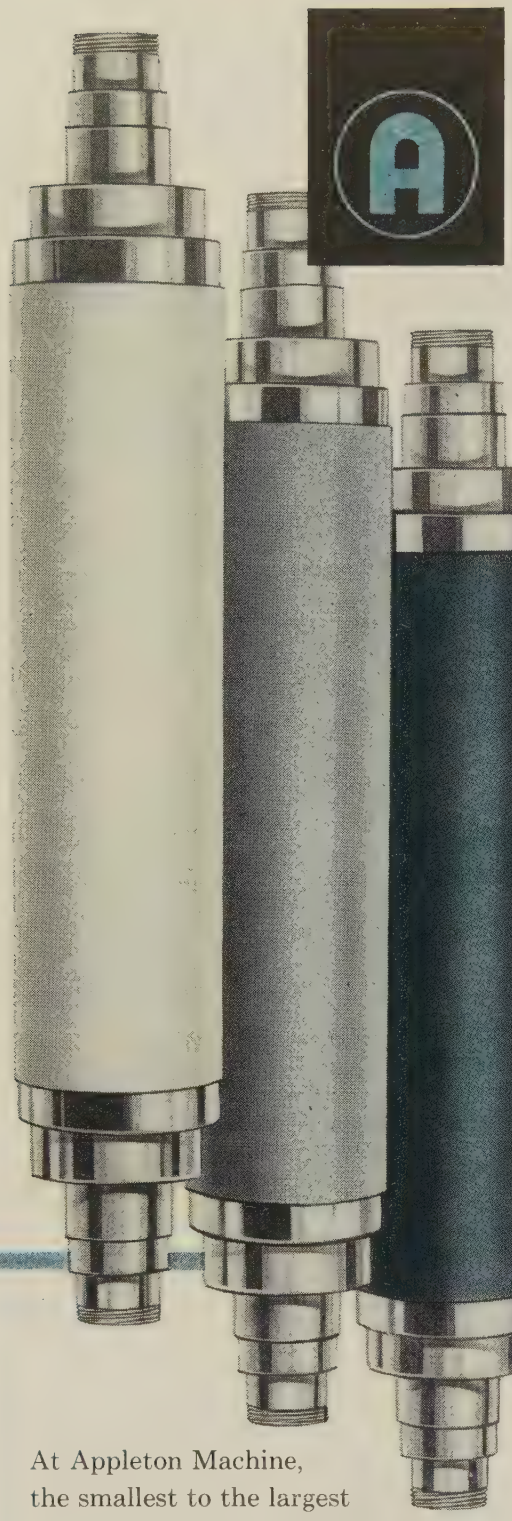

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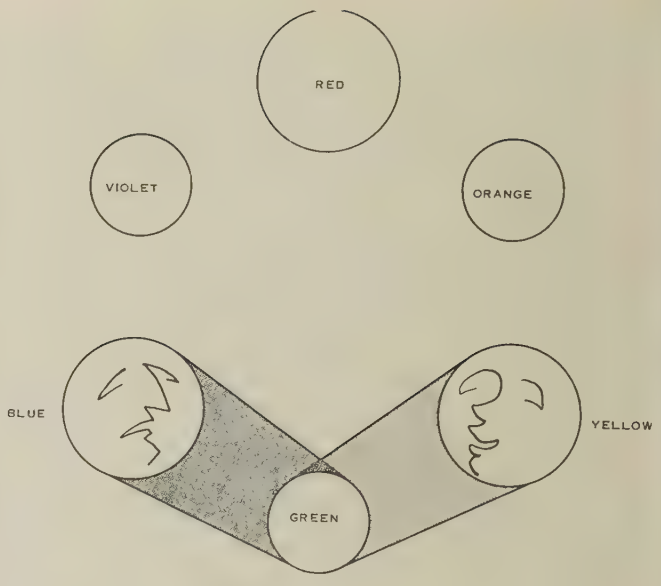


Fig. 3

seen in Fig. 4, and the details of each are indicated in their respective areas.

Our common bond in TAPPI is paper, the very reason for our being here tonight. "Progress Begins with Paper" according to the National Blueprinters Association. (This is their slogan.) Paper has been and is now at the roots of our well being, penetrating nearly every activity of our existence. There are unusual opportunities for paper products in every industrial phase of our life, but tonight I want to jolt your thinking for its use in the visual symbolic and some realistic communications.

Perhaps you recall the story of a Midwest school teacher who was visiting our nation's capitol. While passing the National Archives building she read aloud the inscription on its facade. "The past is merely prelude to the future." She called to the cab driver and asked, "Cabby, do you know what that means?" He promptly replied, "Ya, lady, that means you ain't seen nothin' yet!"

How starkly true this applies to all communications, but especially this is so in the area of our interest tonight.

Look at the circle of this chart (Fig. 4). Paper is the

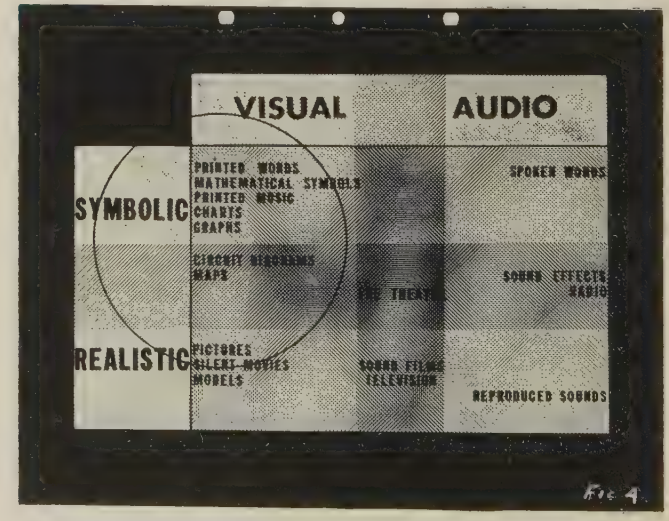
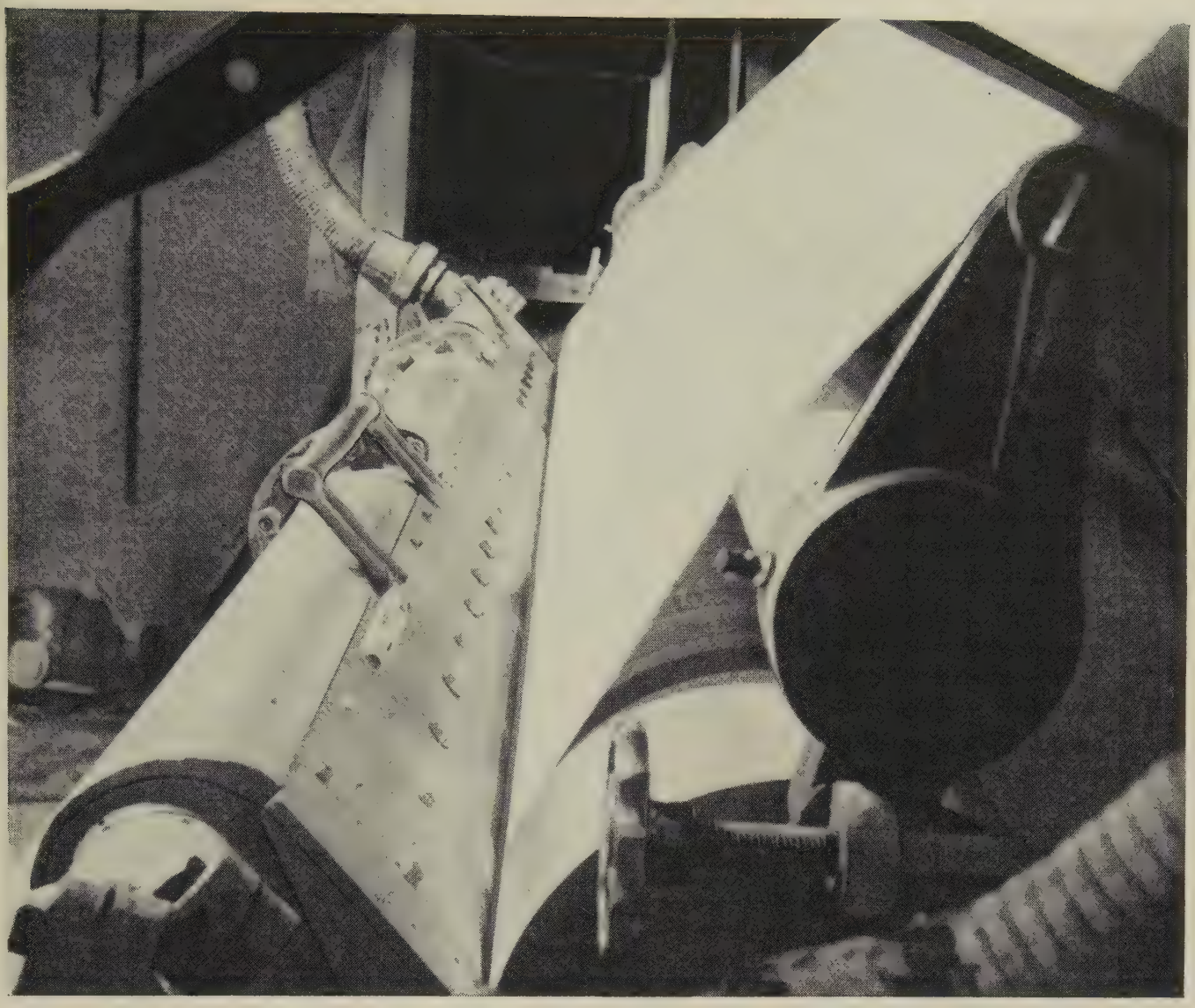


Fig. 4



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most logical medium for motivating these communications and normally final copy is on unprocessed paper. But such paper isn't good enough for the jobs to be done that I have in mind.

The manufacture of high tonnage of inexpensive relatively unprocessed types of paper has been drifting out of New England to the larger, newer, and more integrated companies. These plants, as you know, have to run a mile of stock before their machines are up to speed and their quality control intelligence turns on the green light of product acceptance. In New England we have the older plants with smaller equipment without complete integration from forest, to pulp, to paper, which fixes some limitations but also allows some flexibility, a point which I want to stress later.

Now let's stop and think of the problems around us in data handling. We want to accomplish a series of steps at the speed of light, if possible, and in large measure take final action by dissemination of hard copy in the form of visual and symbolic messages.

Ever-increasing volumes of information are posing problems of enormous complexity. The duplication of research efforts, not just in this country but all around the world, are wasting billions of dollars and endless man hours that could be applied to new creative efforts. One research director of a very large international corporation claims it is cheaper to duplicate efforts costing up to $80,000 than to search for the information that may already exist somewhere else.

This shocking situation was brought into sharp focus on the day that Sputnik I was seen orbiting around the earth. Today, some of the brains, money, and energy that have been going into our own space programs are now not just being used to solve the problems of pooling data and information, but also to make these speedily available to all subscribers of the system.

We hear of digital computers that experimentally can spew out data at the frightening speeds of nearly 60,000 characters per second. Commercial machines are approaching 17,000 per sec., which equals three $8^1/_2$ by 11 single spaced, elite typed sheets per second. If such equipment now in existence were placed in the Pentagon Building operating around the clock, it would be a matter of hours to fill all the space full of paper. Fortunately it is not necessary to record everything those machines can produce because the information can be stored in memory, on tape, wire, film, and other means, thanks to electronic devices.

Specifically these are some of the activities that need to be perfected for data handling:

1. Acquisition—the original data and information is already on paper.
2. Indexing—can be accomplished on card stock, punched cards, tape, etc., all of which could be paper.
3. Abstracting—initial abstracts may be placed on paper prior to some form of electronic memory storage.
4. Filing—a purely mechanized system of placing in orderly position.
5. Storing—an electronic memory on tape, film, aperture cards, composite microfilm or micro-opaque sheets.
6. Retrieving—electronic sorting or scanning procedure.
7. Displaying—visual projection by blowback from memory form to temporary visual form.
8. Reproducing—calling for hard copy directly in print or mat offset duplication.
9. Dissemination—this can be distribution of hard copy or possibly distant telephone dialing or TV pickup where remote receiving devices are used for displaying and making hard copy for further distribution.

Paper must be a part of this picture, but the market penetration will only be in proportion to the amount of work we do about it. Let's digress a minute and make some observations of past performances.

In comparison with other industries, yours in paper is alert, vibrant, and near or at the top by any standards. Only last month, May 8th, the *Wall Street Journal* headlined the "Silent Salesmen" of packaging and stated, "American consumers probably will spend a record of $13 billion this year for the containers in which their food, clothes, and other products are packaged, up from $5 billion only a decade ago. . . . About 2 $^3/_4$% of total expenditures on goods and services now go for packaging compared with 2% in 1949. Packaging's share will climb above 4% inside of 5 years. . . . Today, packages are made from over 200 different materials, including plastics, glass, metal, and paper; in the early 1920's there were less than a dozen such materials."

You of TAPPI competed with other basic materials in packaging. And you with paper have taken a major share in that market of tremendous growth. But your per cent participation is only as secure as you make it by continued research and market visioneering.

Unusual opportunities are knocking at your door right now in the relatively new area of data handling and visual communications. Major changes are taking place fast where answers are needed for problems that might be solved with paper. Such paper is not necessarily as we know it now, but as it might be designed to provide speciality properties for the job to be done. Here are some illustrations that might be helpful in following my thoughts (Figs. 5, 6, and 7).

A desperate competitive race is in full stride to be the firstest with the mostest. The tempo is total research for total survival with planning literally projected into space.

Practical approaches, however, to current data handling problems are in field trials and nearing commercialization. Witness the recent decision of Westinghouse to microfilm all engineering drawings as one step in automation of visual communications.

Referring to these illustrations, common varieties of

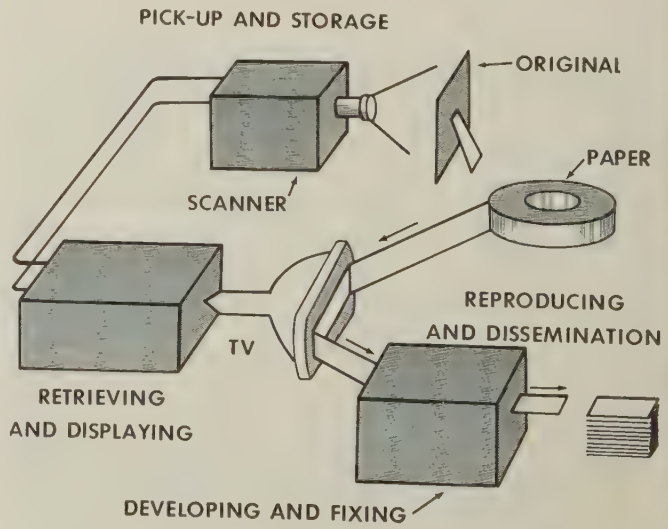
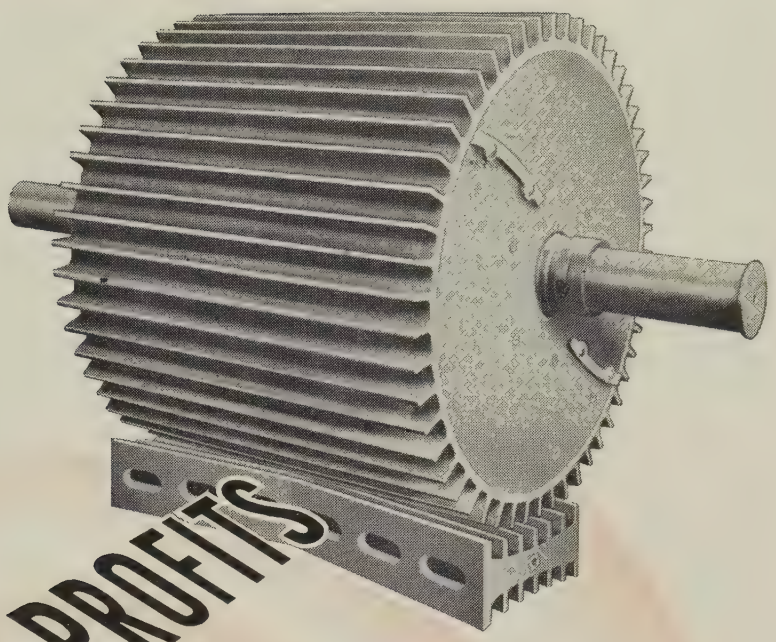


Fig. 5



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paper now used are obvious, but speciality opportunities are yours to consider. Using the science of electrostatics is one means of obtaining hard copy for visual communications (please refer to Fig. 6). Commercial equipment is available now using the selenium plate transfer system developed by Haloid Xerox. Another approach earlier suggested by R.C.A. including special coated papers is making a strong bid for position in this market.

A few examples of progress in these speciality areas are papers coated with elements that become light sensitive when electrostatically charged. Upon exposure, the image is developed by dry toning having charged particles and fused in place permanently with mild heat.

The application can be varied by design to accomplish single print copies at a low cost or to make offset duplicating masters of exceptional quality. These masters can have gradations from short to long press life in producing multiple copies at high speeds very economically.

Processing of these papers is practical both with transmitted and reflected light starting with positive or negative subject matter and ending with copy of your own choice, positive or negative.

Image development can be accomplished by electrostatic means in two ways. Photoelectrosensitivity requires charging the whole area and selectively by light exposure, eliminating unit charges to gain a specific image. Another method is to selectively impinge a charge only where an image is to be developed. Both are capable of producing image resolution of extreme fineness. Exposure speeds of the photoelectrosensitive coatings are quite practical for office copy, microfilm blowback, and lithographic processes (Figs. 6 and 7). The latter approach, however, opens the way to receiving images at speeds produced in the electronic machines previously metioned (Fig. 5).

It doesn't take much imagination to picture thousands of applications where electronic equipment can and will process data, using paper in every phase of collecting, sorting, indexing, abstracting, recording, storing, retrieving, reproducing and distributing, not to mention the possibilities of proofreading and many other time-consuming functions of present-day practices.

Automation of information handling systems will characterize our new era of communications. In any event, factual information must be brought quick and

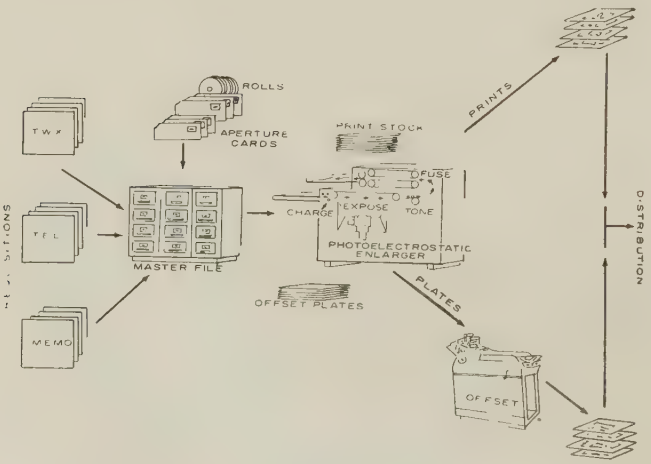


Fig. 6

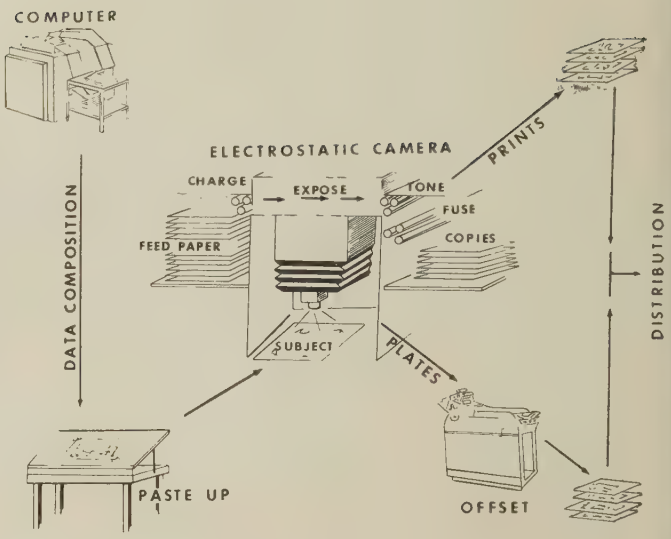


Fig. 7

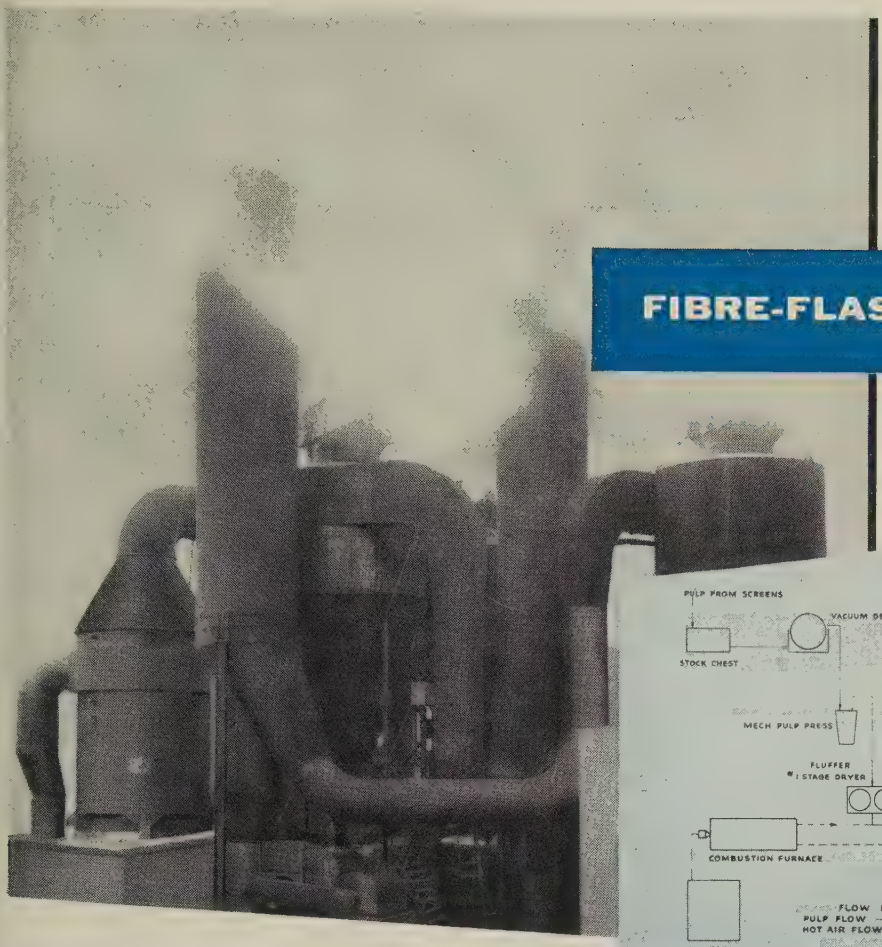
true to the right place at the right time in order that decisions can be made in pace with industry requirements.

In all the illustrations presented a very large portion of the factual information will, of necessity, be completed in visual and symbolic form. Intermediate stages may also take such form. Paper is the logical media of visual-symbolic communications, but it won't necessarily be there when someone pushes the button and copy passes through or comes out of the machines. We have to do something about it now to make sure that paper will be there.

The word "paper" to most people broadly describes a very common low-cost commodity. Those who are more informed and discriminating think of varying grades, colors, uses, etc., but still have the relative low-cost commodity complex.

In our activities at the Plastic Coating Corp. we think of paper as a carrier in, on or through which we can apply a limitless variety of plastic materials, usually from the medium of organic solvents, to accomplish special characteristics of real significance. Such special characteristics imparted to paper which comprises the bulk of the services we offer, generally fall into two categories: *decorative* and *functional*. *Combinations* of both are frequent. A few examples are: colors, overprints, and embossings for decorative reasons; flexibility, toughness, abrasion, and tear resistance as functional requirements; transparency, pencil and ink receptivity to satisfy architects and draftsmen; waterproofness, photosensitizing, even taste and smell to keep you happy while the dentist x-rays your teeth; chemical, grease, and solvent resistance to cap the containers of cosmetics and prescription drugs you buy; heat pressure and moisture seal characteristics that closes your shotgun shell and still permits a perfect pattern of shot. These and hundreds more can be named. The significance is, however, that each new area of endeavor brings on new standards of performance that forces us to institute new qualitative measurements outside of existing patterns to maintain quality control.

At the end point the carrier is no longer paper; in fact some would find it difficult to identify it as paper at all. Fortunately, like the food and beverage industries, those of us associated in TAPPI generally manu-



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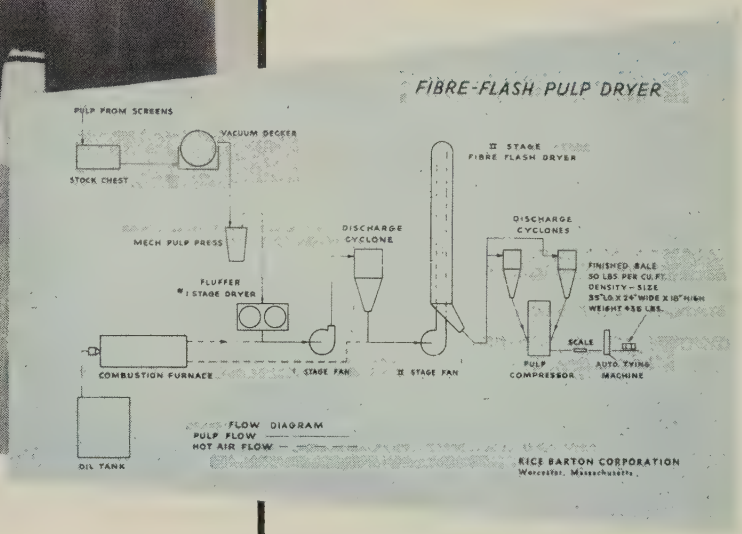

The "Fibre-Flash" drying process for use with all types of pulp consists of dewatering the pulp, fiberizing the concentrated pulp material thoroughly to insure uniform drying, evaporation of the fiber-bound water to the required degree of dryness and baling or bulking the material into convenient form for storage or shipment.

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facture products that are destroyed or consumed in their use. Furthermore, the source elements such as timber for pulp can be replenished in nature. Even the chemical processes that produce resins and solvents for our use go through cycles of regeneration. All this is not exactly perpetual motion but perhaps the closest thing to it in business, and it keeps us all intensely occupied.

To drive a wedge into the market of data handling systems, new functional quality requirements are facing us. The electrostatic papers are an excellent example of illustration.

No single segment of the paper industry can face these problems alone. As specialty plastic coaters, we are obliged in large measure to translate our requirements in terms of new quality standards that must be met by our suppliers. We look to the paper manufacturers to comply with these requirements and to carry a fair portion of the research load. But it goes further back than that. Chemicals and resins for beater additives; the pulps consumed; the timber growth; even rainfall—every inch of activity from elements in nature to the end of the pipeline where goods are consumed or destroyed—everybody and everything contributes to the final performance of the item competing in the market place.

In the visual portion of the communications industry, the Society of the Reproduction Engineers typifies the initiation of any creativity by saying, "In the beginning was a line. . . ." Nearly every meaning of this phrase suggests creativity in visual form.

In the general use of the word "blueprint," certainly "Progress Begins on Paper," as expressed by the Blueprinters Association. In every sense of the written and spoken word, all of us "must draw a line somewhere" to arrive at and to control our productivity within progressively narrower tolerances to keep pace with the quick and true of our era.

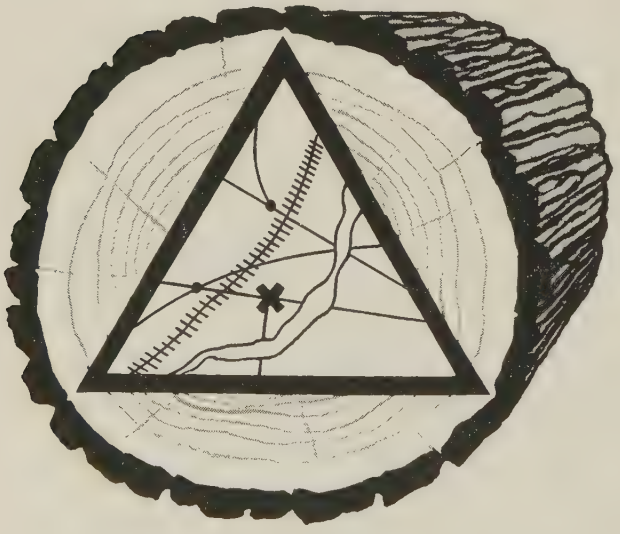
In the TAPPI organization no members are better suited to take full advantage of this specialty market, directly or indirectly, than those representing New England mills. Here we have craftsmen the equal of which are not found elsewhere in this country. Our natural water supply is the purest found anywhere. With ingenious operators, slower speeds and narrower webs, the New England mills have the necessary flexibility to produce specialty products that larger integrated firms of other areas cannot afford to touch.

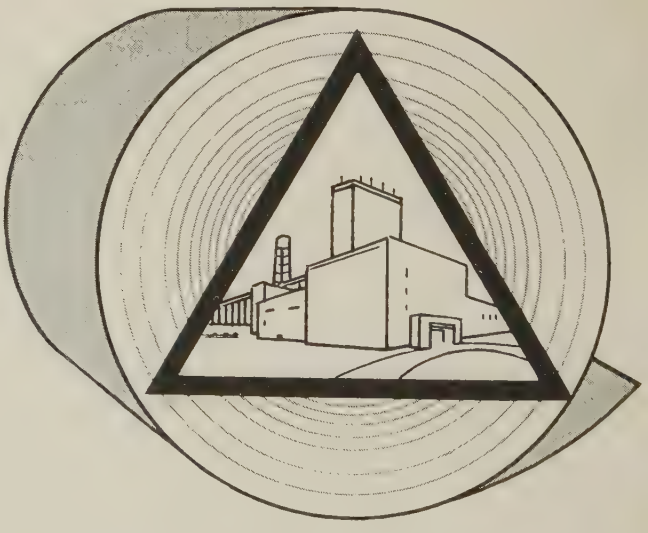
Local conditions distorted by men sometimes disrupt the balance of things about us. The natural laws, however, of science and economics are exacting though equally severe or opportune for ourselves and our competitors alike. So let me finish by revising the opening ditty and make it read like this:

"So keep us quick and keep us true,
Surviving change from new to new."

Presented at the meeting of the New England Section of TAPPI held in Chatham (Cape Cod), Mass., June 5, 6, 1959.

FROM SITE SELECTION TO PAPER PRODUCTION





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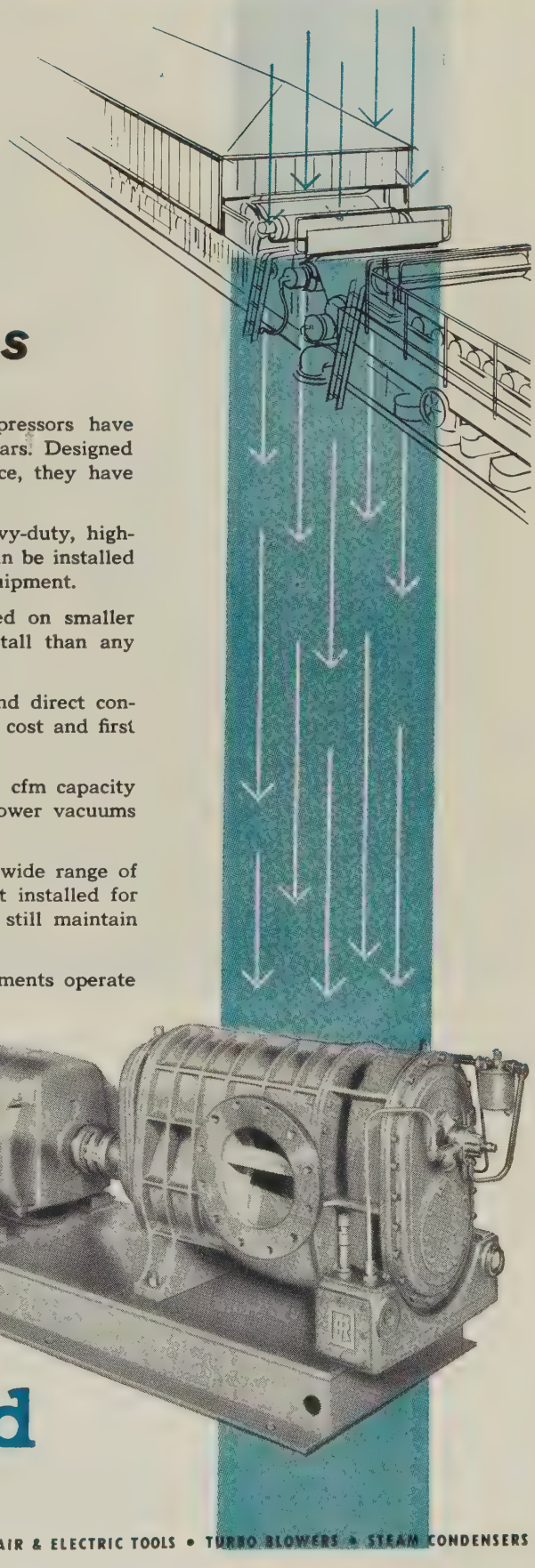
TRONA®

for paper mill
VACUUM SERVICE
only the I-R
Axi-compressor
offers all these cost-saving advantages



Proven Reliability. Thousands of horsepower of Axi-compressors have been operating successfully in vacuum service for many years. Designed for higher pressures and heavier loads in compressor service, they have extra, reserve strength on *vacuum* service.

Compact Construction. Smaller in size than any other heavy-duty, high-capacity vacuum pumps, they are often the *only* units that can be installed in available space to increase the production of existing equipment.

Low Installation Costs. Axi-vacuum pumps can be mounted on smaller foundations and are more economical to transport and install than any other vacuum units in their pressure and capacity range.

Low Power Costs. Designed for high operating efficiency and direct connection to higher speed motors, they save on both operating cost and first cost of drive equipment.

Low Seal Water Requirements. Less than 1 gpm per 1000 cfm capacity provides ample seal for vacuums of 12″ Hg and higher. Lower vacuums require no seal water at all.

Greater Versatility. Any Axi-vacuum pump can provide a wide range of vacuum simply by changing the driver horse power. A unit installed for high vacuum, may be used on lower vacuum services and still maintain its high operating efficiency.

Low Maintenance. The two dynamically balanced rotor elements operate with no metal-to-metal contact, virtually eliminating mechanical wear.

Wide Range of Sizes. The large number of sizes permits meeting practically all vacuum requirements from a standard line. Each unit can be selected for actual inlet conditions, and changes in inlet temperature have little effect on capacity. Axi-compressors are available in capacities to 12,000 cfm for vacuums to 22″ Hg single stage and 26″ Hg two stage. Ask your I-R representative for complete information.

Ingersoll-Rand

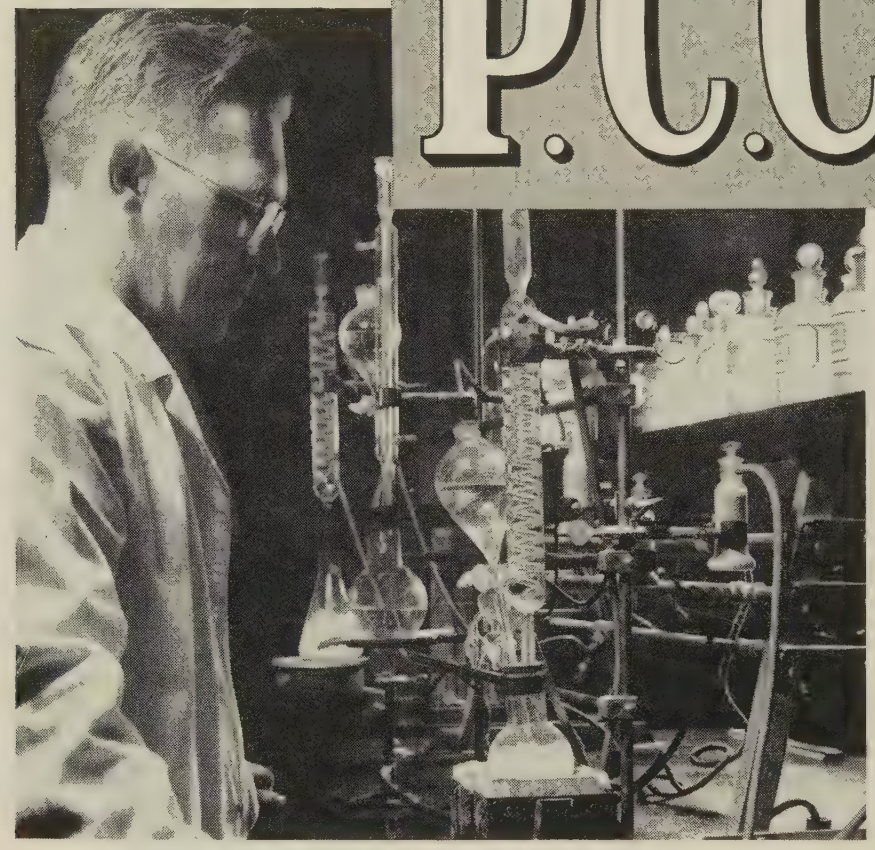
17-913 11 Broadway, New York 4, N.Y.

PUMPS • CENTRIFUGAL & RECIPROCATING COMPRESSORS • DIESEL ENGINES • AIR & ELECTRIC TOOLS • TURBO BLOWERS & STEAM CONDENSERS

..here's why
MISSISSIPPI LIME COMPANY

P.C.C.

Precipitated Calcium Carbonate



meets your most exacting requirements

We start with a raw material of superior quality. Mississippi Lime Company's entire limestone deposits have a natural purity and uniformity unequalled in such quantity anywhere.

This pure limestone — through a series of carefully controlled processes – is then converted to the various uniform grades of PCC in widespread use by paper companies that demand the best.

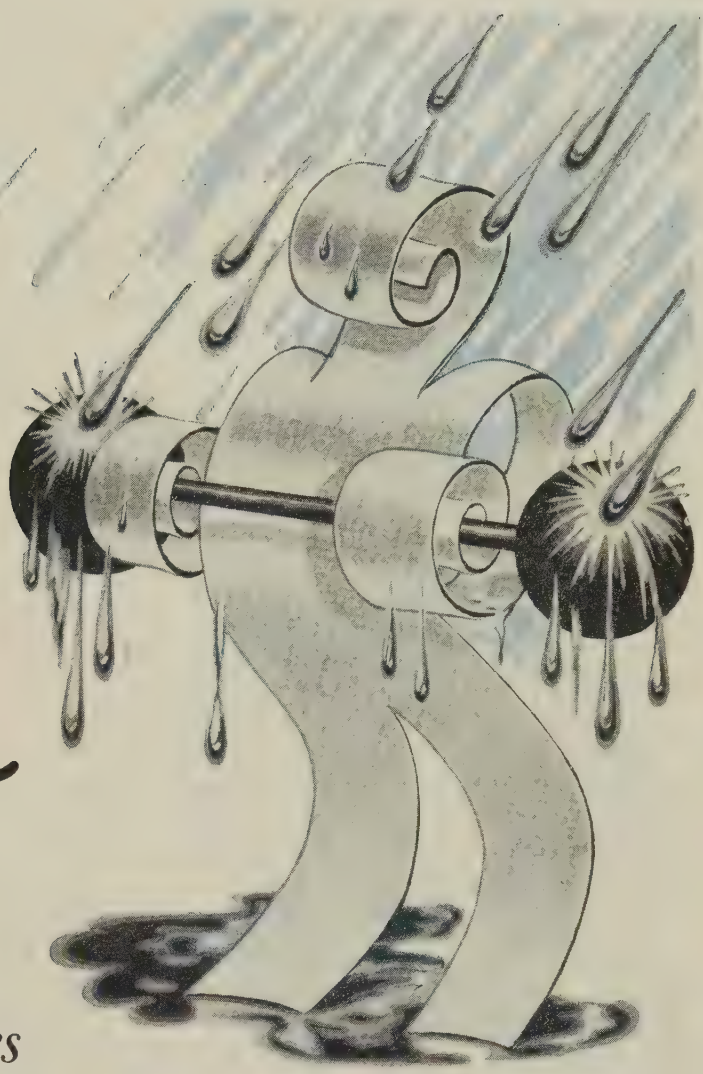
When you specify Mississippi Lime Company PCC for paper coating, you can be sure of:

high brightness *excellent printability*
smooth surface *uniformity*

Our skilled technicians will consider it a privilege to assist or consult with your technical staff.

For samples write to

MISSISSIPPI LIME COMPANY
ALTON, ILLINOIS



NEW!

Catalin

RESIN 301

substantially increases

WET STRENGTH

without increasing cost

Because it is more efficient, Catalin Resin 301 . . . a modified, cationic urea-formaldehyde resin . . . can substantially upgrade wet strength with the same percentage of resin solids previously used . . . or cut resin costs by maintaining present wet strength properties with less resin solids. You gain in other ways too . . . Catalin Resin 301 is lighter in color . . . and reacts exceptionally well in the presence of dyes. Dry tensile, mullen and folding endurance is also improved.

Usable in a wide variety of bleached and unbleached pulps, Catalin Resin 301 develops about 50% of its final wet strength as it leaves the machine . . . full cure is reached within 2-3 weeks. Since wet strength is developed slowly, broke can be easily reclaimed.

Samples, specification sheets, laboratory data and technical assistance are yours for the asking. Catalin welcomes your inquiry.

Catalin

Catalin Corporation of America
One Park Avenue, New York 16, N. Y.

PLANTS:
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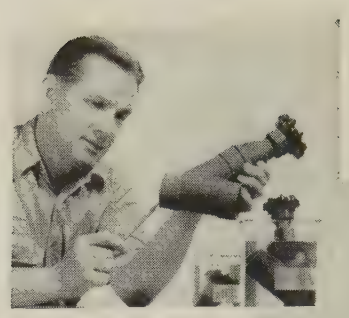
the **WALWORTH CUSTOMER**

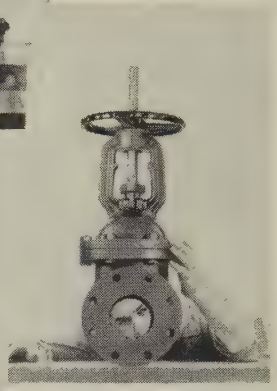
looks for specialized durability in

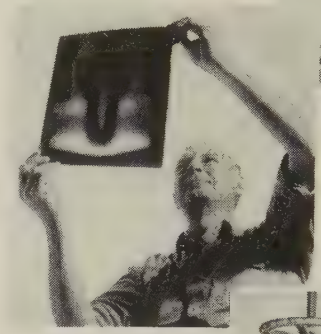
BRONZE, IRON, STEEL, LPV, PLASTIC *and*

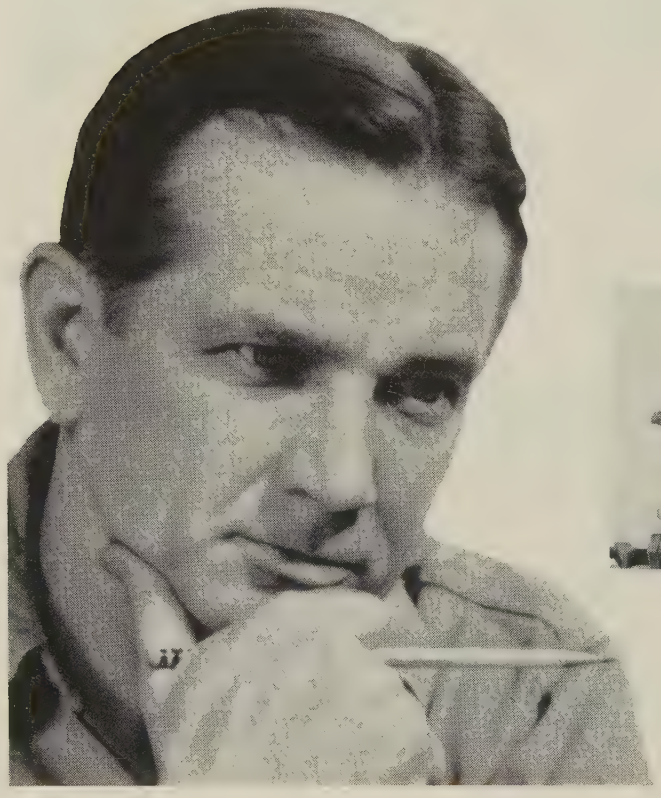
PRESSURE-SEAL VALVES

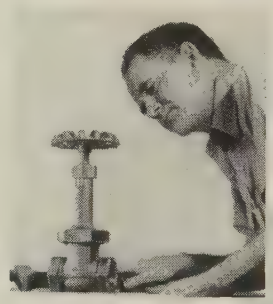
. . . and here's how he gets it

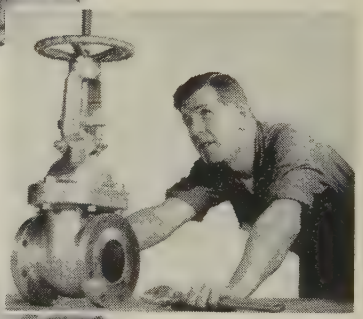












When the Walworth Customer selects valves for special needs in fluid flow control, he insists on knowing that each type will do its job for a long time, with minimum maintenance. In Walworth Bronze Valves, for example, he finds generous wall thickness, and extra-large stems with extra-deep threads.

In Iron Body Gate Valves, the Walworth Customer checks fully open valves for the free flow of fluids. He finds streamlined ports in the Walworth Cast Steel Gate Valves to fight turbulence and pressure drop.

Tight and fast closures are on his mind when he decides on an LPV, and he finds 100% tight closure in the Walworth Lubricated Plug Valve. It is lubricant-sealed against leakage, opens or closes with a quarter turn, and can be serviced under pressure.

To control corrosive fluids the Walworth customer investigates plastic valves and in Walworth PVC Valves and Fittings he finds his answer. For PVC *cannot* corrode. Problems in extreme pressure and temperature lead the Walworth Customer to Pressure Seal valves. He learns that in the Walworth Pressure Seal Cast Steel Valves all pressure containing castings are radiographed to assure their complete soundness.

In his persistent quest for hard facts about materials, workmanship and high quality in the special valves he buys, the Walworth Customer gets his decisive answers in products bearing the Walworth name. If you, too, insist on verifying solid quality for yourself whenever you buy valves, we want you, too, for a Walworth Customer. For the newest literature on any type of Walworth Valves get in touch with your Walworth Distributor.

Or write **WALWORTH** *750 Third Avenue, New York 17, N. Y.*

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WALWORTH SUBSIDIARIES: ALLOY STEEL PRODUCTS CO. • CONOFLOW CORPORATION • GROVE VALVE AND REGULATOR CO. M&H VALVE & FITTINGS CO. • SOUTHWEST FABRICATING & WELDING CO., INC. • WALWORTH COMPANY OF CANADA, LTD.

Unique chemical process, discovered by Staley research, makes possible a new advance in surface sizing and coating

New MIRA-FILM Acetate Gum

The Result of a New Basic Chemical Discovery by Staley

MIRA-FILM Acetate Gum is recommended for sizing and coating all grades of paper where optimum surface characteristics, high strength and excellent film-forming properties are required.

MIRA-FILM Acetate Gum sets new standards in uniformity . . . is non-congealing and stable in viscosity. Has good water retention . . . produces clear, flexible films. Pick tests are improved . . . adhesion in pigment coating is exceptional.

MIRA-FILM Acetate Gum is available in a *complete* range of viscosities. Why not investigate this significant advancement for yourself? Contact your Staley Technical Representative or write:

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A. E. STALEY MFG. CO., DECATUR, ILL.

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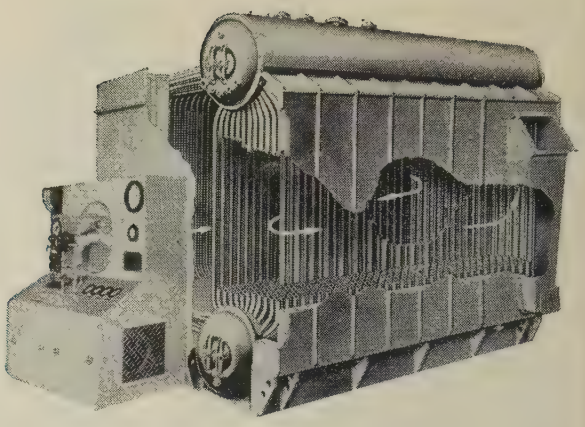
C-E Power Boilers for the Pulp and Paper Industry



C-E Package Boiler, Type VP—Completely shop-assembled . . . available in 23 sizes from 4,000 to 90,000 lb of steam per hr capacity . . . pressures to 700 psi . . . temperatures to 750F in certain sizes . . . available with integral console control panel. This unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type. For oil or gas firing.

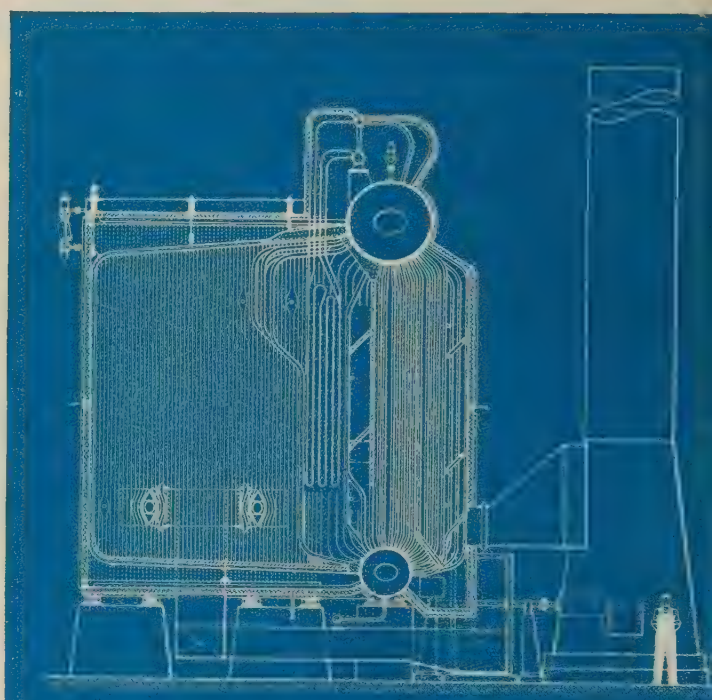
C-E offers boiler designs for any pressure, temperature and capacity . . . for any fuel or combination of fuels. The units illustrated here include both standard and custom designs with capacities from 4,000 to 750,000 lb of steam per hr, with pressures to 1350 psi and steam temperatures to 950F. Two units are for oil or gas firing. The other four are available for coal, oil, gas or bark firing—either singly or in any desired combination. In addition to those illustrated, there are other designs available for more specialized applications.

Whether you wish to add steam capacity to your present power plant — or build a single large boiler to meet all your steam needs — these units allow you a freedom of choice never before available. In addition to making full utilization of your bark supply, you can choose a supplemental purchased fuel best suited to the economics of your area for use when your bark supply is inadequate or your steam needs exceptional.

All these boilers have been proved in operation. They perform reliably and economically and — no matter what your combination of fuels or steam conditions — are designed to meet your needs exactly.

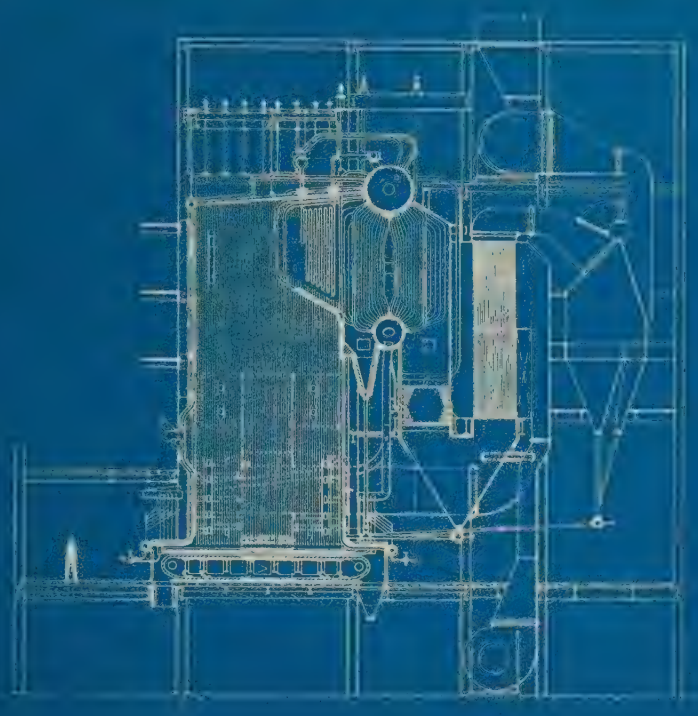
For further information, contact the C-E office nearest you. Or, if you prefer, write or phone the C-E Paper Mill Division in New York.

C-198A

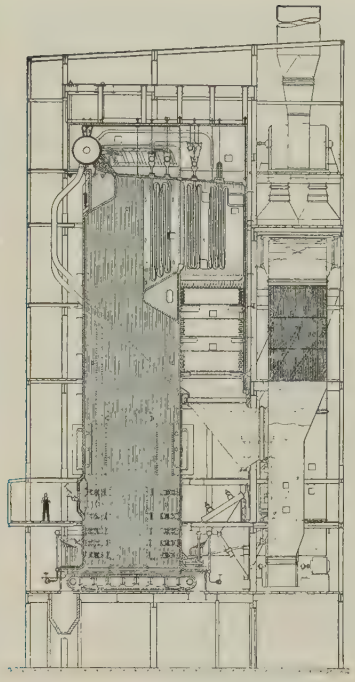


C-E Vertical-Unit Boiler, Type VU-55 — Available in five sizes . . . capacities from 50,000 to 120,000 lb of steam per hr . . . designed for three pressure ranges: 250, 500 and 700 psi, and total steam temperatures up to 750F. Equipped with tangential burners, 60-inch steam drum assures generous water capacity and steam reservoir space. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance. For oil or gas firing. Available with heat recovery equipment, if desired.

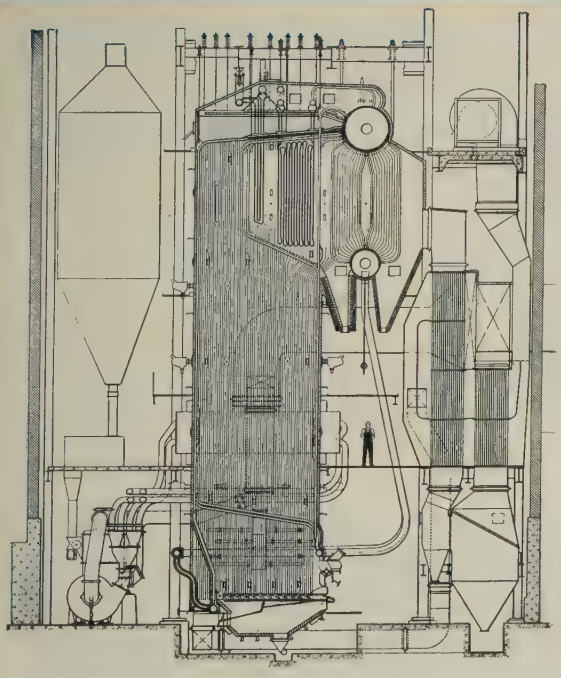
These drawings show but a few of the many types of C-E boilers available for pulp and paper mill use which burn two or more fuels. Not illustrated here is the C-E Chemical Recovery Unit.



C-E Vertical-Unit Boiler, Type VU-40 — fired by C-E Tilting Tangential Burners and a C-E Continuous Discharge High Set Spreader Stoker. This unit is designed to burn natural gas, oil, coal and bark . . . a baffleless boiler with capacities ranging to about 300,000 lb of steam per hr with pressures to 1350 psi, temperatures to 950F.



C-E Radiant Type Boiler — Type RX — for bark, oil, natural gas, stoker or pulverized coal firing in any combination. Available in capacities to 750,000 lb of steam per hr, with pressures to 1350 psi and temperatures to 950F. The unit pictured is fired with a C-E Continuous Discharge High Set Spreader Stoker and C-E Tilting Tangential Burners.



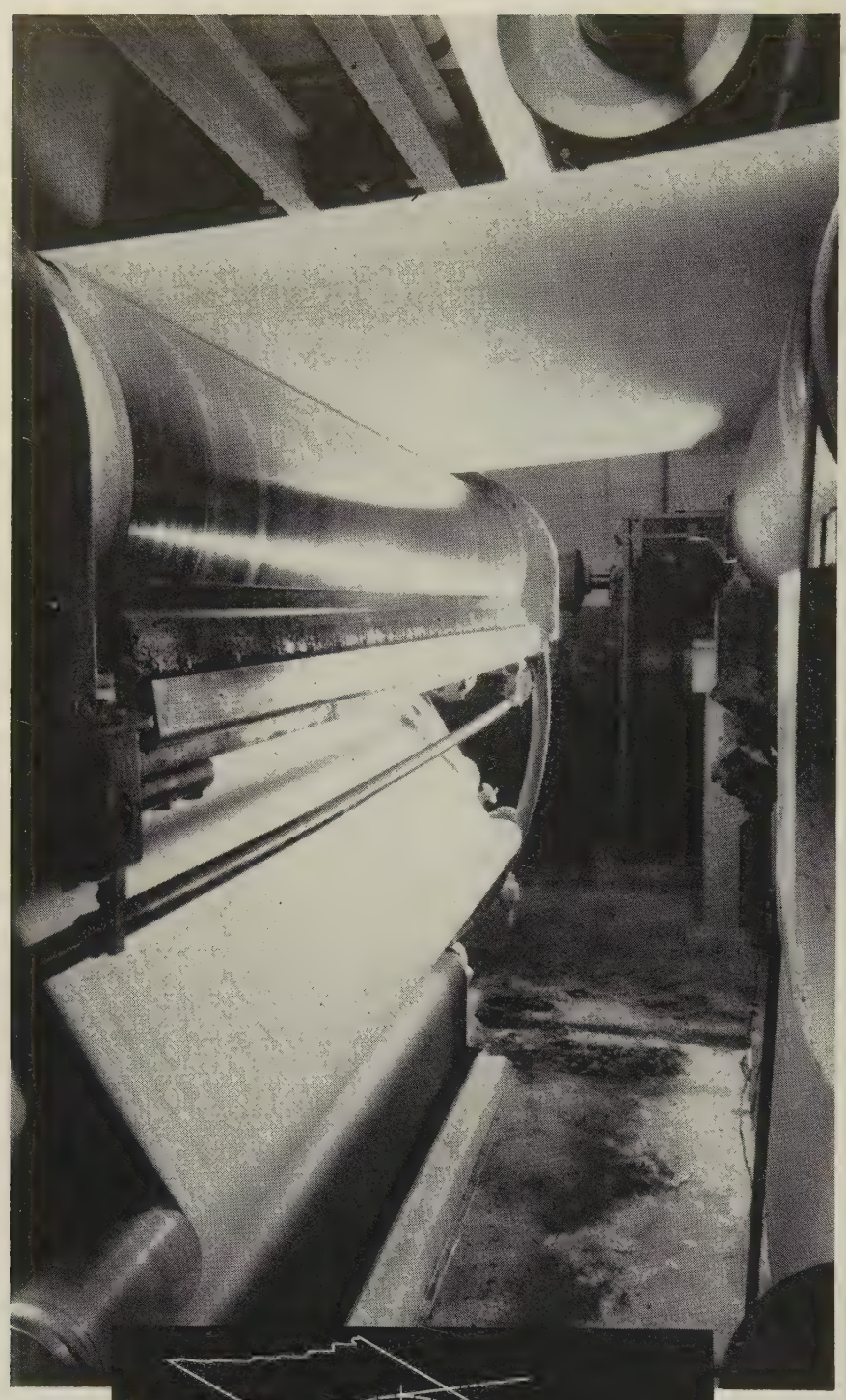
C-E Vertical-Unit Boiler, Type VU-40 — for capacities to about 300,000 lb of steam per hr, pressures to 1350 psi and temperatures to 950F. For pulverized coal and bark firing, singly or in any combination. The unit illustrated is equipped with C-E Bowl Mills, C-E Tilting Tangential Burners and a C-E Dump Grate Spreader Stoker.

C-E Vertical-Unit Boiler, Type VU-10—fired by a bark and coal burning C-E Spreader Stoker. VU-10 Boilers are available for capacities to 50,000 lb of steam an hr, with pressures to 500 psi and temperatures to 650F. This unit type is available for coal, oil, gas or bark firing — singly or in combination.

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



Lodding Press Doctors ride with the roll

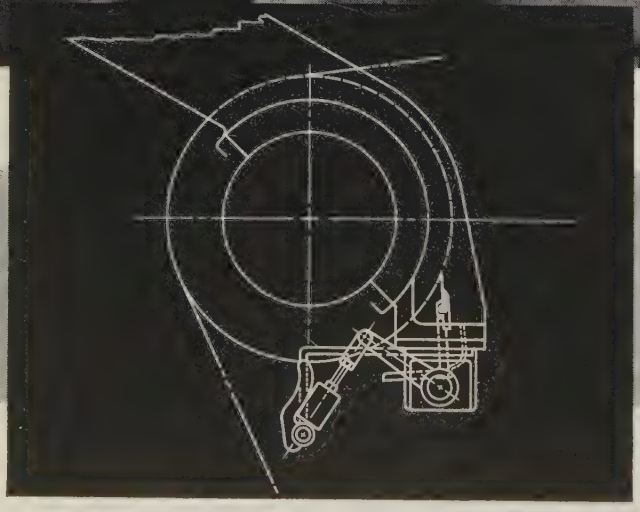
THE MECHANICALLY OSCILLATING top press roll doctor pictured here was custom made for the second press on No. 4 machine at the Sorg Paper Company. It was planed to conform exactly to the crown in the roll. Afterwards, it was optically checked, by means of a special alignment telescope, to make certain it came within critical tolerance specifications.

Mounted on the press arms, this Lodding Press Doctor always rides with the roll — in perfect balance, perfectly aligned with the axis, no matter what position the roll takes. Steady, uniform pressure is exerted by the blade over its entire length with no danger of damaging the roll covering.

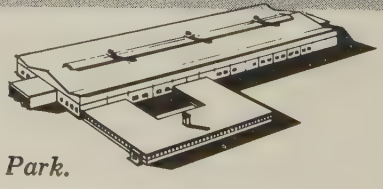
Thousands of custom-engineered Lodding Doctors, like this one at Sorg, are performing dependably on all kinds of machine rolls in mills everywhere. That's because each doctor was precision made by specialists for a specific application.

So whether you need doctors for press rolls or any others, from Fourdrinier to reel, you get guaranteed satisfaction in Lodding Doctors.

Get in touch with Lodding or your nearest sales representative for complete information.



LODDING
Engineering Corporation
AUBURN, MASSACHUSETTS



We welcome your inspection of our new plant located in Worcester's Auburn Industrial Park.

GELVATOL

designed for greater size...ability

For surface sizing paper or board, water soluble GELVATOL resins offer dramatic increases in strength, transparency, grease resistance and printing qualities. Can be applied by any of the conventional methods: tub, size press, and calender stack.

Why not make a test run and notice the—

Increased Strength. GELVATOL sizing significantly increases the Mullen and fold endurance of rag stock and other high quality paper.

Increased Transparency. GELVATOL sizing improves the gloss, grease-resistance and transparency of glassine.

Increased Grease-Resistance. Surface sizing with GELVATOL makes paper grease-resistant; surface coating makes paper grease-proof. Improves wax holdout.

Increased Printability. GELVATOL imparts a smooth finish to paper. Improves ink holdout and contrast. Provides excellent varnish holdout.

GELVATOL is available in a wide variety of grades. Whatever your sizing needs it will pay you to write for full technical information to Shawinigan Resins Corporation, Department 6210, Springfield 1, Massachusetts.

SALES OFFICES: ATLANTA CHICAGO LOS ANGELES
NEW YORK SAN FRANCISCO

GELVATOL® *polyvinyl alcohol by*

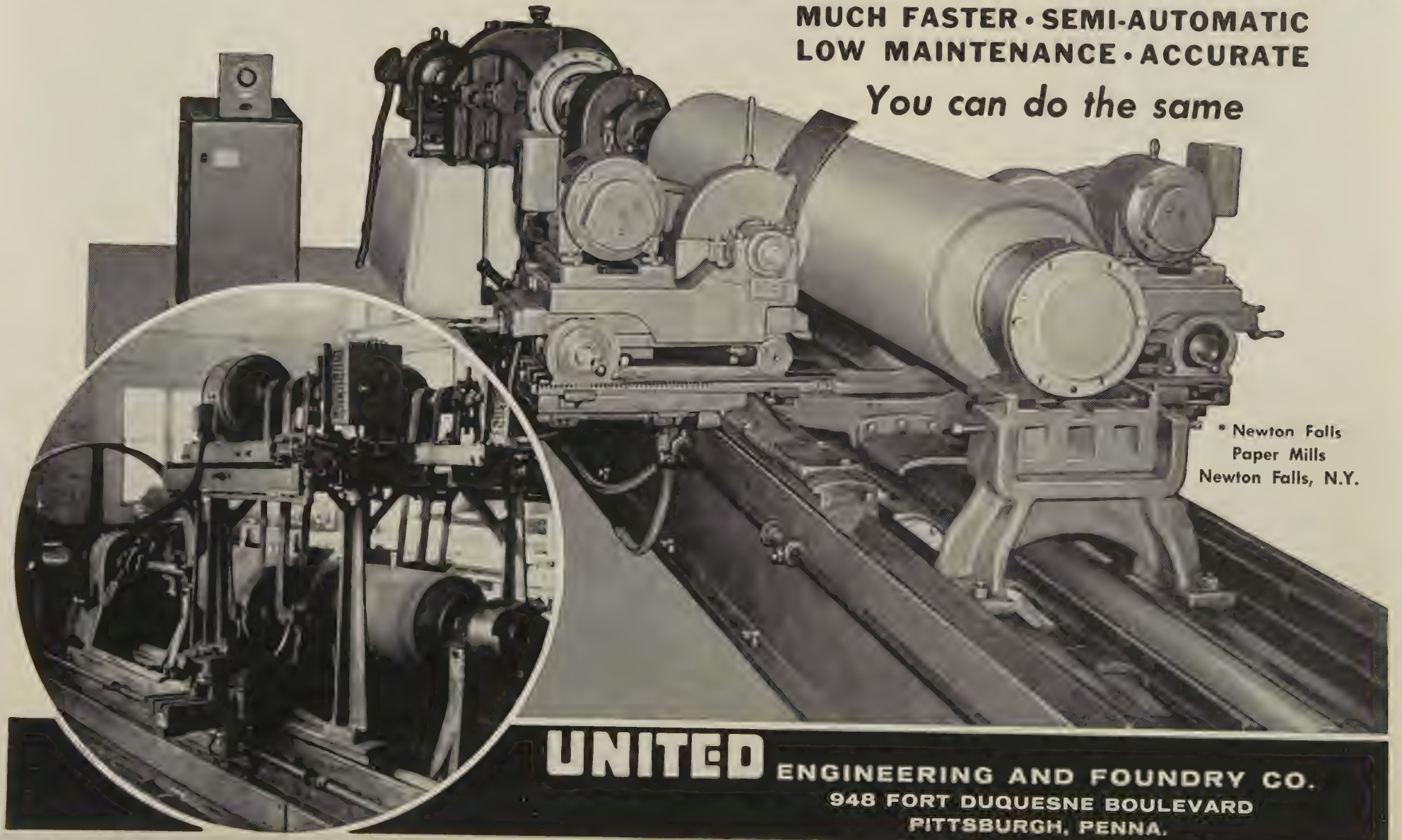
SHAWINIGAN RESINS®

NEWTON FALLS* MEETS TODAY'S SPEED-UP

Modernizes Their LOBDELL Roll Grinder

MUCH FASTER • SEMI-AUTOMATIC
LOW MAINTENANCE • ACCURATE

You can do the same



* Newton Falls
Paper Mills
Newton Falls, N.Y.

UNITED ENGINEERING AND FOUNDRY CO.
948 FORT DUQUESNE BOULEVARD
PITTSBURGH, PENNA.

New Emphasis on Ion Exchangers In Paper Making

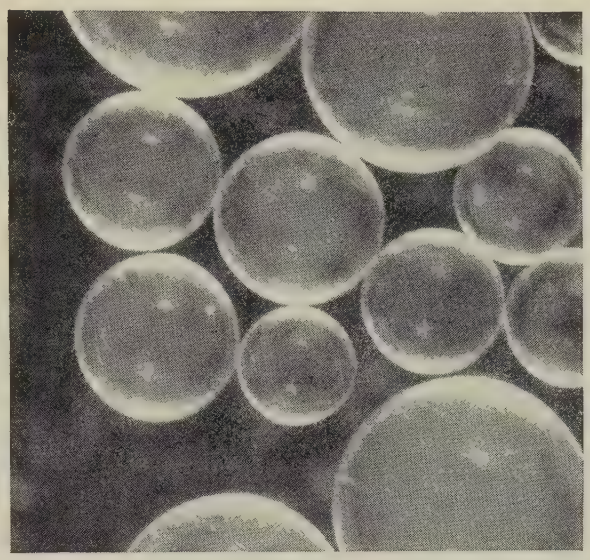
New *Nalcite* resins broaden water treatment scope; make demineralized water practical in wider range of paper mill applications

Bringing ion exchange—and especially demineralization—within the practical range of paper mill water treatment cost, handling and volume requirements is the job now being done with Nalcite Ion Exchange Resins for conditioning a variety of mill waters. Their practicality for these jobs is putting new emphasis on demineralization for producing high quality water at reasonable cost.

New Nalcite resins are new only in that they have recently been released for industry-wide use.

Nalcite HCR-W . . . pretested for four years . . . is a proven cation exchanger of superior physical stability, and is the latest addition to the series of high performance Nalcite resins.

Nalcite SBR-P . . . in slightly more than 3 years since its introduction this highly porous, strong base anion exchanger has surpassed performance expectations.



Nalcite HCR-W under the photomicroscope looks like no other ion exchange resin: clear, perfectly-formed microspheres, stress-free, crack-free, virtually breakage proof in any known ion exchanger service.

Better Water = Better Paper

Demineralized water for *process chemicals preparation* provides a solid base for making uniform solutions which will perform predictably. Other important examples are *aqueous coating solutions* and *dilution water for making electrical condenser paper*. Nalcite-demineralized water, having extremely high electrical resistance, goes far toward helping produce the dielectric strength in finished condenser paper that users want, but not always have been able to obtain.

Steam Production

Demineralized boiler feedwater solves a multitude of steam generation operating and maintenance problems at once. Use of Nalcite Ion Exchangers in modern demineralizing equipment is the surest source of top quality feedwater . . . water that helps produce steam at lowest possible cost.

Higher Physical Stability is Key To New High in Performance

Nalcite HCR-W cation exchanger is teamed with Nalcite SBR-P anion exchanger for top demineralizer performance—in either multiple bed or mixed bed systems. Stress relieved HCR-W bead microspheres are virtually shatterproof. Similar stability of SBR-P assures low pressure losses—and pressure drop stays at design figures since there are no fines to fill spaces between beads or clog strainers, distributors or controls. Backwashing and regeneration are quicker, more efficient with Nalcite exchanger beds.

New Ion Exchange Text Available

Full description and discussion of the many methods of modern ion exchange utilization is contained in Nalcite Bulletin Z-5. Bulletin Z-7 describes new HCR-W. Write for your copies now.

National Aluminate Corporation is now

NALCO CHEMICAL COMPANY

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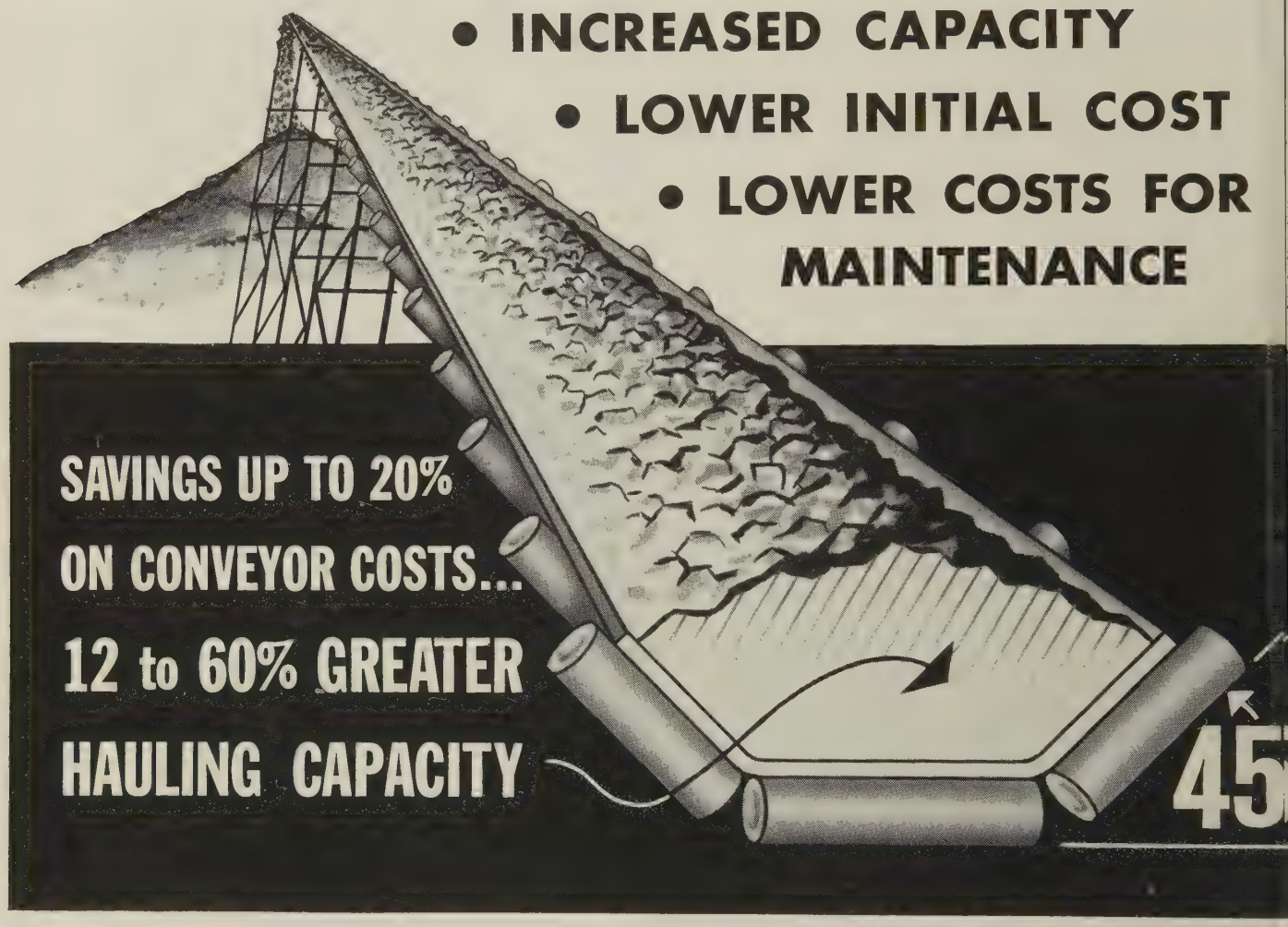
nalco® ...Serving Industry through Practical Applied Science

Nalco CHEMICALS
Nalcite RESINS

MOST IMPORTANT NEWS

NOW YOU CAN USE 45° IDLERS


• INCREASED CAPACITY
• LOWER INITIAL COST
• LOWER COSTS FOR MAINTENANCE
SAVINGS UP TO 20% ON CONVEYOR COSTS...
12 to 60% GREATER HAULING CAPACITY
45

It's a mathematical certainty that a belt can haul bigger loads with 45° idlers than with regular 20° idlers. But the 45° angle between concentrating idlers and bottom roll idlers is too sharp for an ordinary heavy duty conveyor belt. Plies separate, but modern RAY-MAN CONVEYOR BELT licks this problem . . . for all time!

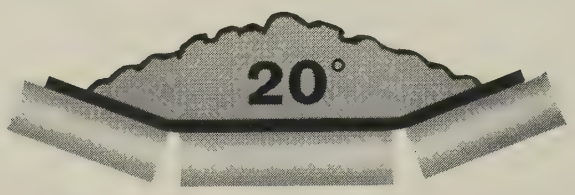
Ray-Man's exclusive flexible construction and built-in stress compensation is guaranteed to take the sharp angle of 45° idlers without ply or cover separation at the hinge line. This opens a whole new era of conveyor design . . . permitting larger loads . . . narrower conveyors . . . assuring longer cover wear . . . lower handling costs!

RAY-MAN GIVES YOU "*MORE USE PER DOLLAR*" WITH 45° IDLERS

IN CONVEYING TODAY!

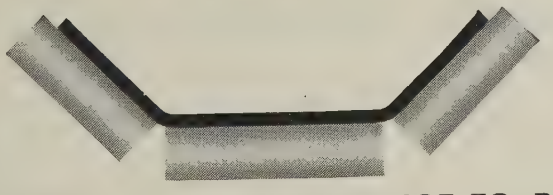
...TO HANDLE ALL MATERIALS

BIGGER LOADS, LESS SPILLAGE, LESS WEAR ON COVER WITH 45° IDLERS

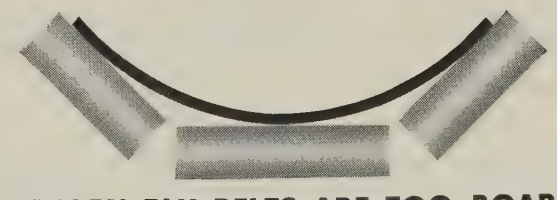


20° IDLERS REQUIRE WIDER CONVEYOR TO HAUL SAME TONNAGE

Only RAY-MAN CONVEYOR BELT is BUILT to take the EXTRA STRESS OF 45° IDLERS



RAY-MAN IS GUARANTEED NOT TO PLY-SEPARATE AT 45° ANGLES



ORDINARY PLY BELTS ARE TOO BOARDY TO TAKE 45° ANGLES

Ask your R/M representative to show you how Ray-Man Conveyor Belt with 45° idlers can give you the most for your conveyor dollar . . . write for new Bulletin M303, "Ray-Man for 45° Idlers."

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

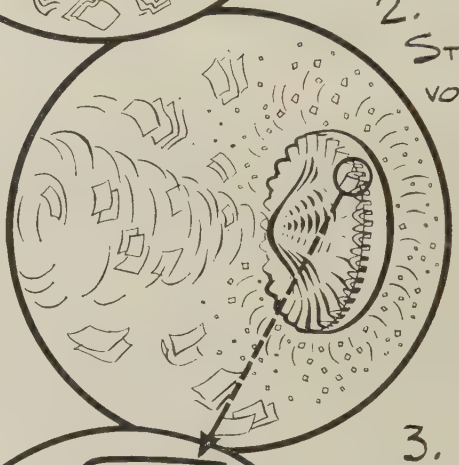
RM-961
ENGINEERED RUBBER PRODUCTS ... MORE USE PER DOLLAR

MORDEN "SLUSH-MAKER"

COMPLETELY DEFIBERS PULP SHEETS, BROKE AND PAPER STOCK — EVEN WET STRENGTH — HERE'S HOW!

1. BALES OR BROKE ARE QUICKLY SHREDDED BY TIPS OF ROTOR BLADES —

2. STRONG, TURBULENT VORTEX PULLS THE SHREDS INTO THE ROTOR, WHICH BREAKS THEM INTO SMALL FLAKES



3. FOLLOW THE ARROWS — SEE HOW THE FLAKES FLOW DOWN THE ROTOR FACE AND IMPINGE AT A RIGHT ANGLE AGAINST THE ATTRITIONING RING WHERE THE TWO SETS OF BARS RUB THE FLAKES APART INTO INDIVIDUAL FIBERS →

WRITE OR CALL US FOR MORE INFORMATION

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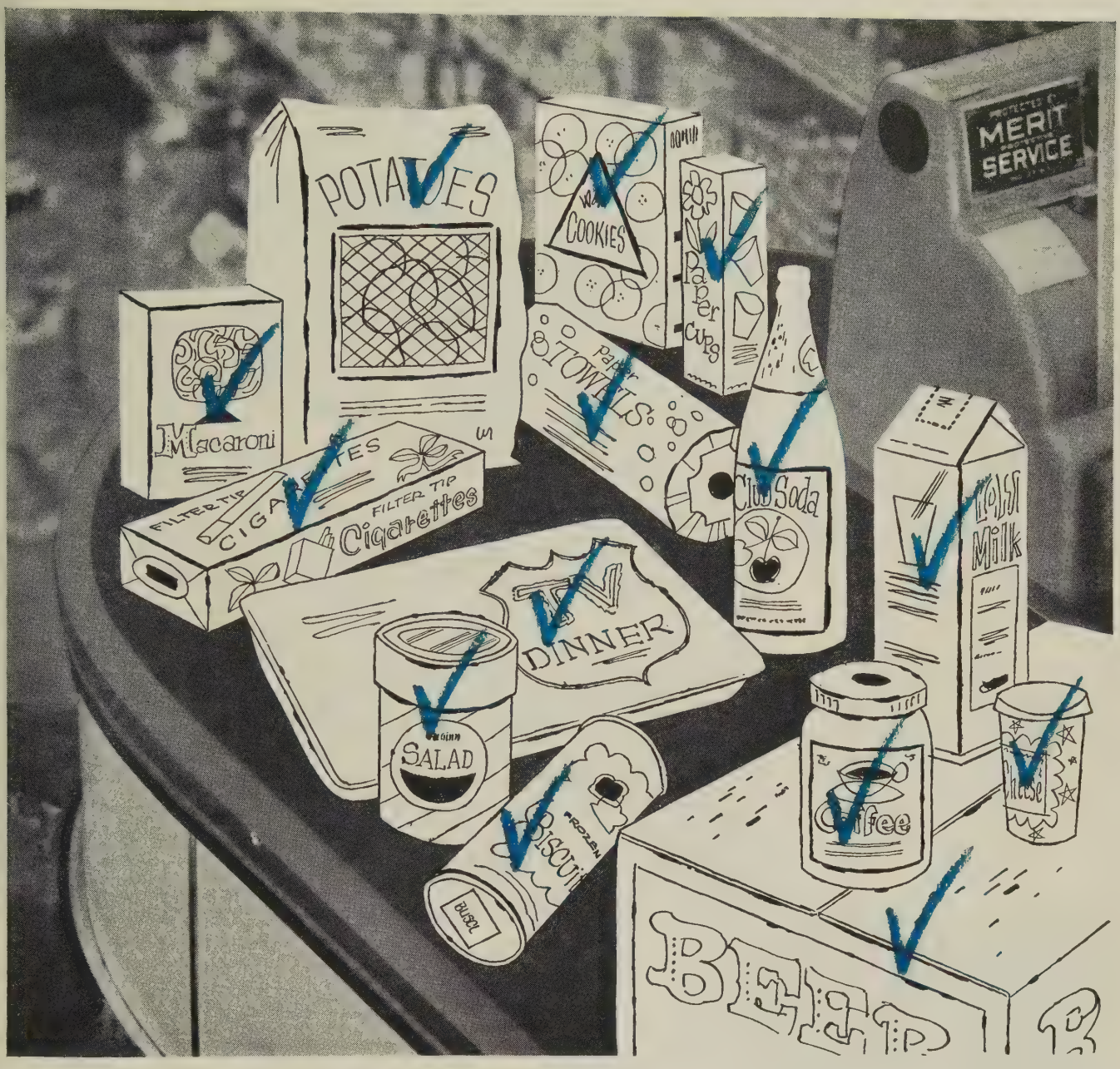

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Bags, boxes, cups, cartons, films, foils, labels, laminates—whatever your bonding requirement—there's a Borden adhesive that is *right* for your operation. Now Borden makes it easier than ever to pick the *one best* adhesive for your needs. Just look it up in Borden's new Adhesives Index. It's packed with valuable working data you can use. Get a copy by mailing the coupon to The Borden Chemical Company, 350 Madison Avenue, New York 17, N.Y.

IF IT'S A **Borden Chemical**

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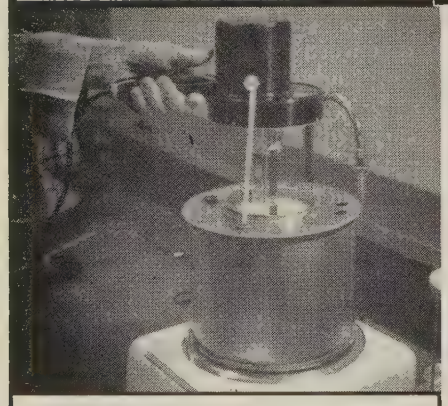
STARCHES ...for every Paper Mill Operation!



TO LOWER COSTS...
call on Hubinger Technical Service. You can depend upon our laboratory facilities and trained field personnel to supply the best and most economical solution to your starch and adhesive problems.

There are OK BRAND products—made especially for every paper mill operation that calls for starches and adhesives. Best of all, there is no extra tariff on any of these top-quality Hubinger items. If your mill needs special starch products to meet improved quality or strength specifications, let our nearest paper-starch technical service representative study your needs. He is prepared to quickly offer valuable aid. Just phone or wire us.

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PAPER NEWS

from Allied Chemical

page 2-3...
increase pulp brightness

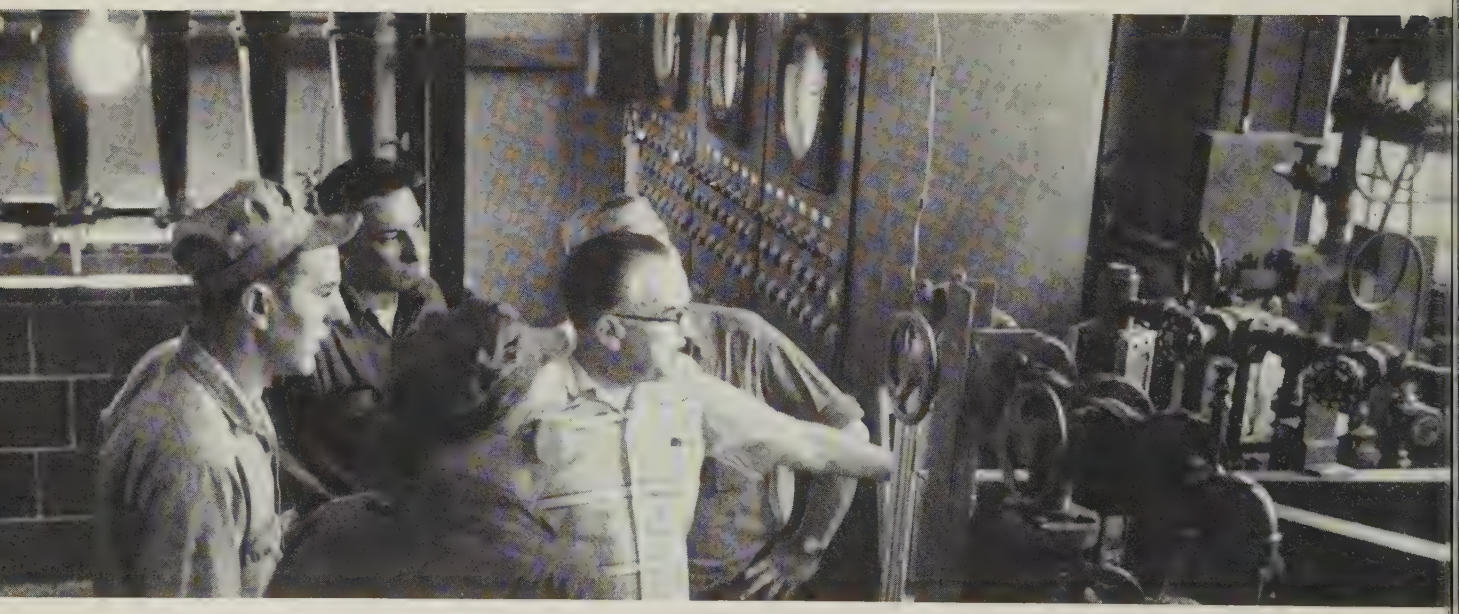
page 4...
solve carton "fiber scratch"

page 5...
cut costs of paper color

page 6...
alum for all paper needs

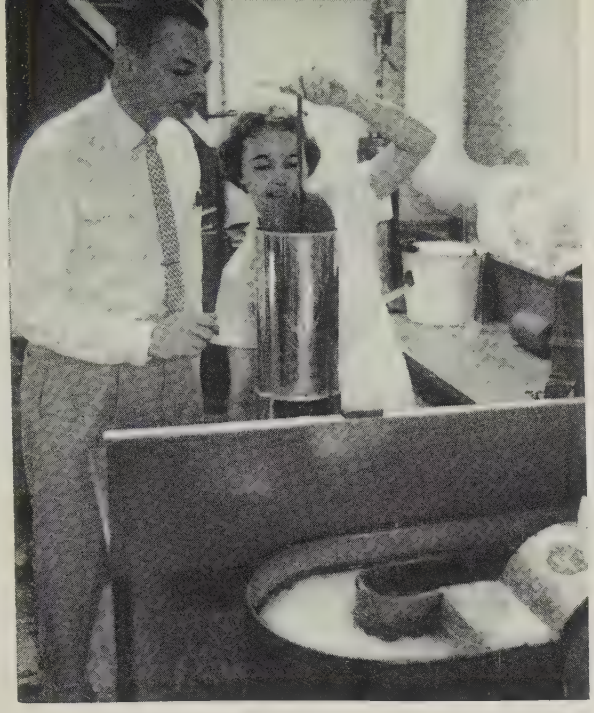
page 7...
shorter pulp cooking time

• *technical service helps increase pulp brightness 7 to 12 points with hydrogen peroxide bleaching*



Solvay technical man helps pulp mill start hydrogen peroxide bleaching process

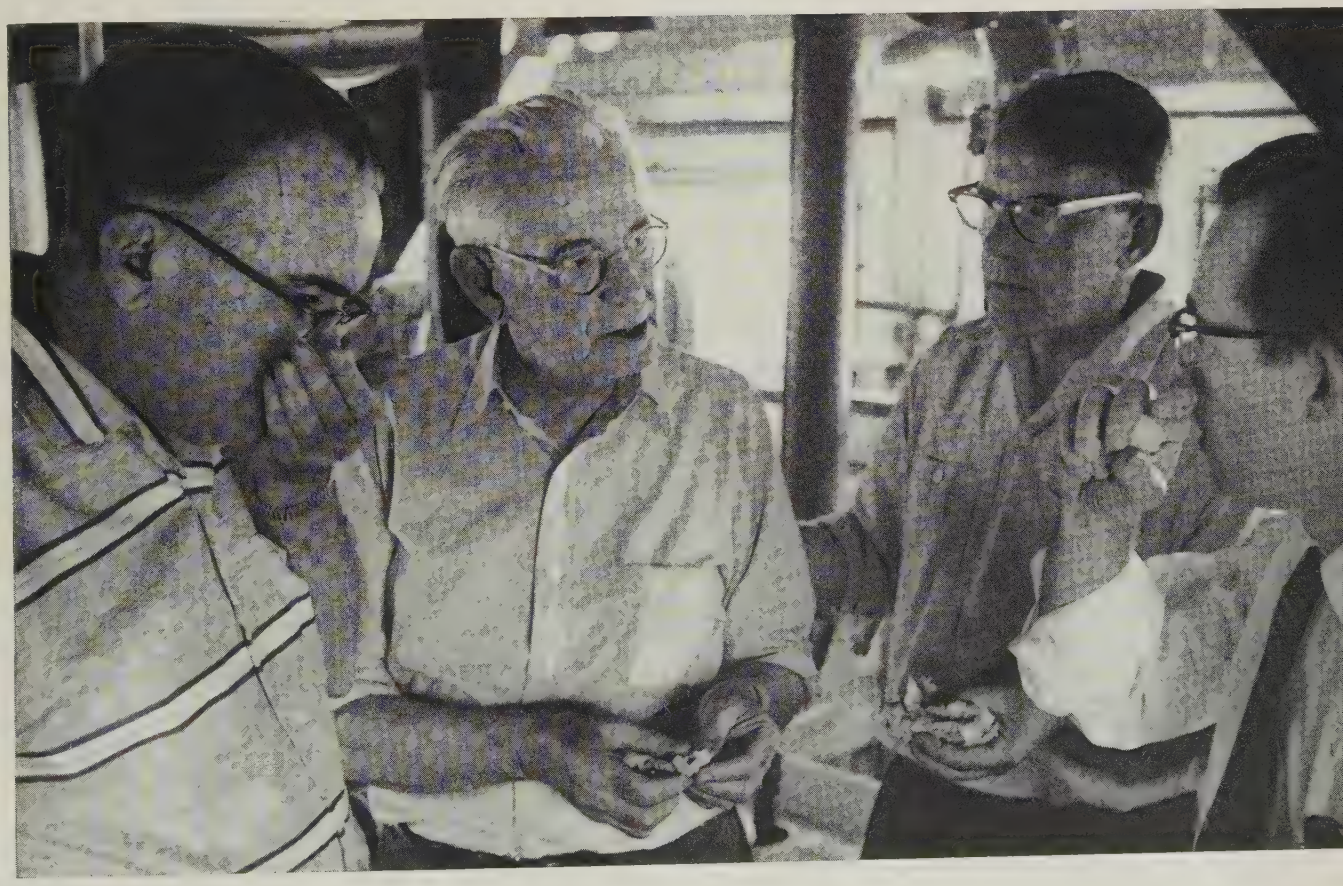
Want whiter, brighter pulp? Substantial increase in whiteness and brightness can be realized with SOLVAY hydrogen peroxide bleach formulas and techniques. These processes are adaptable to all kinds of wood pulps — chemical and mechanical — and often require no large capital investment. Advantages are superior color stability, cleanliness, high yield, and retention of unbleached strength.



Solvay tech service lab in Syracuse is miniature pulp and paper mill

Solvay technical service is in a unique position to advise you on hydrogen peroxide bleaching, being the only hydrogen peroxide producer with interest and experience in all fundamental bleaching procedures. If you are not bleaching with hydrogen peroxide, why not ask us about a preliminary survey to determine its applicability to *your* product requirements.

■ SOLVAY PROCESS DIVISION



SOLVAY is an Allied Chemical trademark

• *"fiber scratch" problem solved for carton manufacturers*

Coaters of cartons for appliances and fine furniture find a new ally in Semet-Solvay's A-C polyethylene. Wax coatings incorporating this new polymer eliminate the "fiber scratch" problem formerly solved only by the use of costly liners. Added advantages: less wax consumption and no "rub-off" on coating machinery. For details, and literature, see the last page.

■ **SEMET-SOLVAY PETROCHEMICAL DIVISION**

A-C is an Allied Chemical trademark

The difference between those two brown papers is not the amount of dye*, but the exceptional cold-water solubility of ERIE Brown 3GNP. Improved solubility increases dye yields, cutting your paper color costs. Cold-water solubility has been built into many new NATIONAL paper dyes; some of the others are ERIE Black GP, Brilliant Paper Yellow C, ERIE Yellow YP and ERIE Benzo 4BP. Write for a complete list of quality improved paper dyes.

• *paper color costs cut with improved solubility*

*Each sample represents 100 Mgs. (Dry) in 3 grams of pulp.

■ NATIONAL ANILINE DIVISION

ERIE and NATIONAL are Allied Chemical trademarks

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DENVER WORKS
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• *Alum—where you want it...how you want it...when you want it*

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NATIONAL WORKS
Cleveland, Ohio

NEW ORLEANS WORKS
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PORT ST. JOE WORKS
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PORT ARTHUR WORKS*
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No matter what your alum requirements are — for setting size in paper, controlling pH of stock system, setting chemicals in wet strength paper or other important paper-making applications — General Chemical, America's foremost producer of alum, can fill all your needs. 28 strategically located plants provide a reliable source of high quality alum, liquid or dry, on a day to day delivery basis. In addition, General Chemical offers capable technical service to help customers solve technical problems.
Write for our informative "Aluminum Sulfate" brochure.

■ **GENERAL CHEMICAL DIVISION**

*In Canada: ALLIED CHEMICAL CANADA, LTD.

• *ammonium bisulfite pulping:*
key to shorter cooking time, increased production

Another step forward in woodpulp processing is ammonia-based pulping. Substituting ammonia for calcium in bisulfite pulping produces pulp of superior quality while it shortens cooking time, reduces the cost of steam per ton of pulp and permits a simultaneous increase in output. Added advantages over the traditional calcium process include wider choice of pulpwoods, easier pollution control. Write for more information.

■ **NITROGEN DIVISION**

• *basic to America's progress*

Allied Chemical

For more information, write
Allied Chemical Corporation, Dept. 109-A
61 Broadway, New York 6, New York.

In Canada:
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1450 City Councillors Street, Montreal

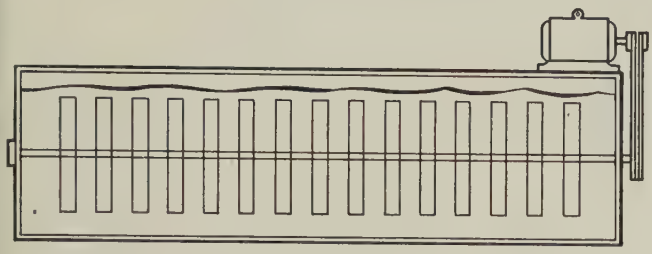
• *principal products for the paper industry*

BARRETT DIVISION • BARRETT building materials • **GENERAL CHEMICAL DIVISION** • Aluminum sulfate • Glauber's salt • Salt cake • Sodium silicate • Sulfuric acid • **NATIONAL ANILINE DIVISION** • Adipic acid CAPROLAN polyamide fiber • Fumaric acid • Maleic anhydride NACCONATE diisocyanates (in coatings) • NACCONOL detergents and emulsifiers • NACCOTAN dispersing agent and mordant • NADONE cyclohexanone • NATIONAL paper dyes • Phthalic anhydride • **NITROGEN DIVISION** • Ammonia liquor • Anhydrous ammonia • Formaldehyde Methanol • Triethanolamine • U. F. Concentrate-85 • Urea • **PLASTICS AND COAL CHEMICALS DIVISION** • CUMAR resins • ELASTEX plasticizers Fiber pitch • PLASKON urea resins • Solvents • Tar acids • **SEMET-SOLVAY DIVISION** • A-C polyethylenes — Emulsifiable for paper size or coating Hot melt low molecular weight for coatings • **SOLVAY PROCESS DIVISION** Ammonium bicarbonate • Calcium chloride • Caustic soda • Chlorine Hydrogen peroxide • MUTUAL salt cake • Soda ash • **INTERNATIONAL DIVISION** • Marketing Allied Chemical products abroad

Items above appearing in light face capital letters are Allied Chemical trademarks.

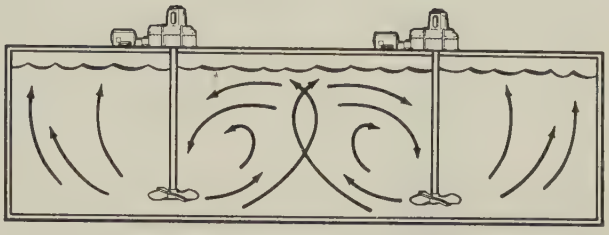
Printed in U

Look what happened when this mill stopped **sloshing** *and started* **mixing** *stock*



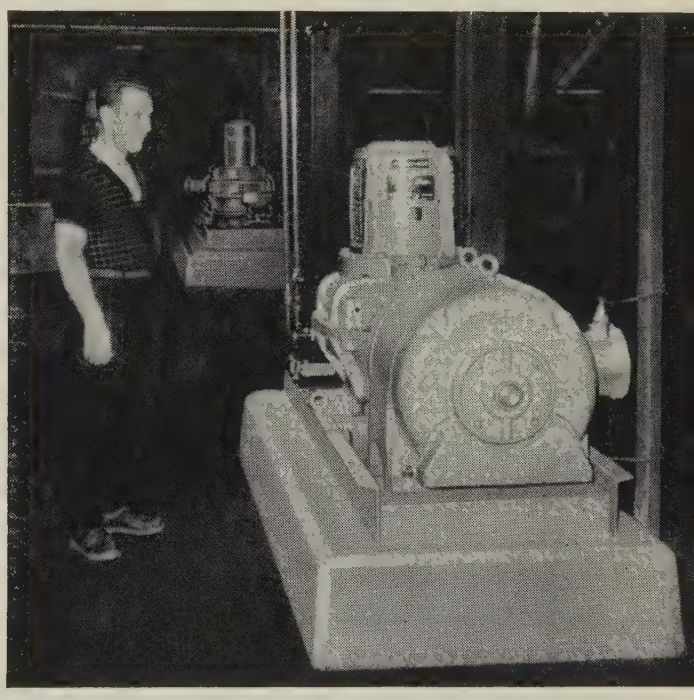
1. Familiar story? A large newsprint mill* was having a tough time getting a uniform 3½% feed of groundwood and sulfite from its mixed stock chest. The stock was churned with paddles on a horizontal shaft, in a chest 56′ long, 17′ wide, 16′ high. But the paddles were *sloshing* the stock instead of mixing it. This caused wide swings in consistency.

*Name on request



2. "Why put up with it?" said MIXCO engineers. "You can get *complete uniformity* with two LIGHTNIN Mixers that look like this. Every pound of stock will be thoroughly mixed from the instant it enters the chest. No dead areas—no stagnation—no stratification—no sudden ups and downs in consistency. What's more, we'll *guarantee* that LIGHTNINS do the job."

3. "Sounds good," said mill engineers, "but will we have to modify our chests to install these units?" "Not at all!" said the MIXCO men. "Make the whole change over one week-end. They come ready-assembled and aligned to minimize your down-time." Here's one of the two LIGHTNINS being installed. It drives a 54″ stainless steel propeller with four adjustable blades.



4. Results? "Since installing LIGHTNINS we've repeatedly beaten our best previous daily production record," say mill engineers. "Effluent is so uniform that we're better off pumping directly to the machine, bypassing a machine chest entirely. Consistency of the stock varies *less than 0.2%* between any two points in the chest at any time!"

Can you make productivity jump with this kind of mixing? More than 100 mills are doing it! No need to guess—you can get the precise power level you need to do the mixing job you want done in a given chest within a given time. It costs you nothing to find out how. For quick, competent service, call in your LIGHTNIN Mixer representative (listed in Thomas' Register). Or write us direct.

Lightnin® Mixers

MIXCO fluid mixing specialists

Ask for these illustrated bulletins describing LIGHTNIN Mixers:

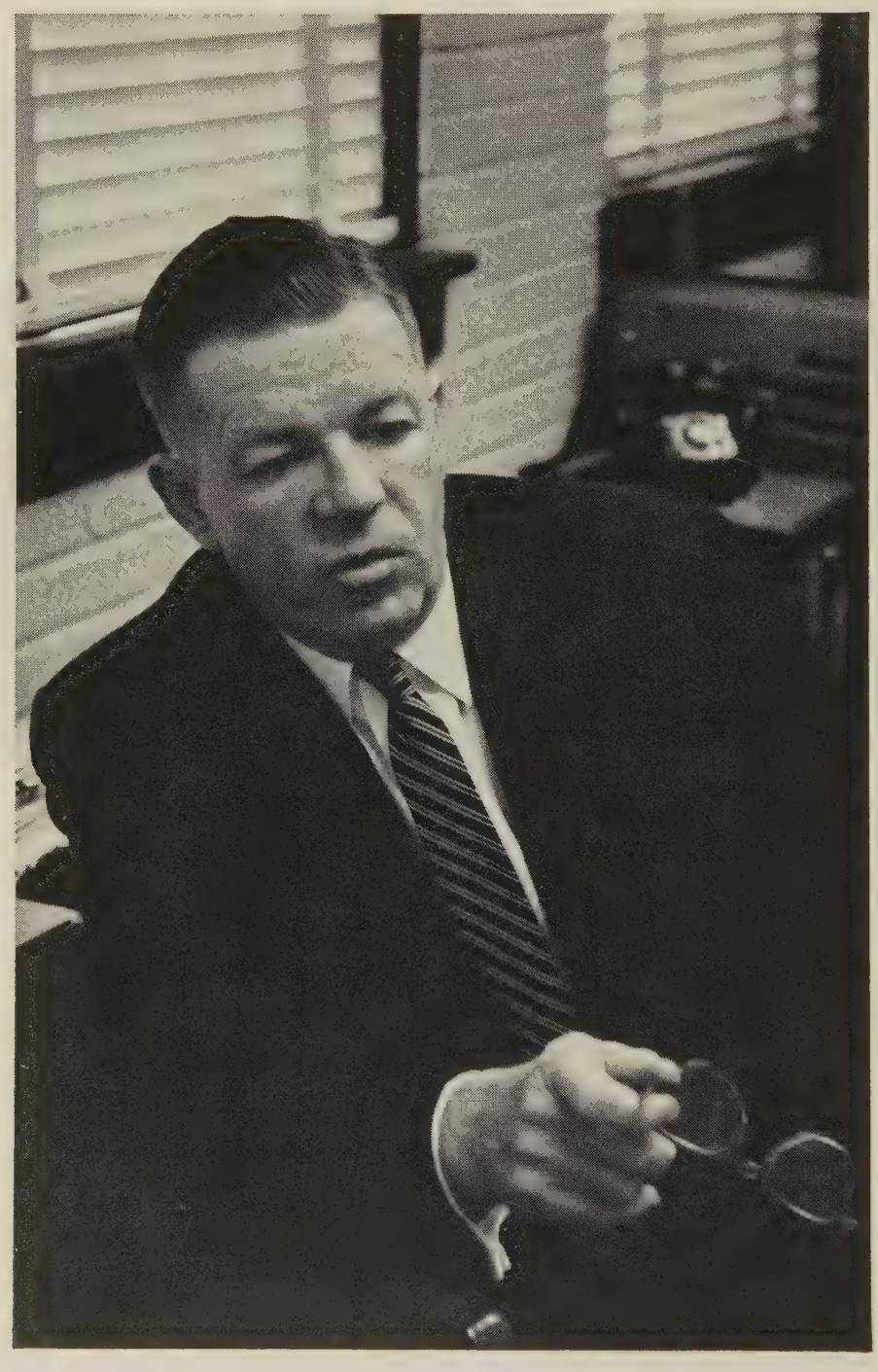
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Data sheet for figuring general mixer requirements (B-107)

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 142-k Mt. Read Blvd., Rochester 3, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

"New information about reducing agents keeps setting off new waves of project studies. The results... frequently a better product at lowered cost."



Dr. Mearl A. Kise, director of research and development, Virginia Smelting Company

An important part of "Virginia" policy is to assist paper manufacturers in the efficient application of their reducing agents in order to provide an improved process or significantly reduced production costs, or both. The newly developed uses in turn lead other manufacturers to reinspect their processes and discover the advantages of using "Virginia" chemicals and accompanying technical service.

Dr. Kise, who heads up "Virginia" research and development, discusses this aspect of his company's products and services.

Q How many reducing agents does "Virginia" produce?

A Five—liquid sulfur dioxide, sodium bisulfite anhydrous, zinc and sodium hydrosulfites, and hydroxylamine sulfate.

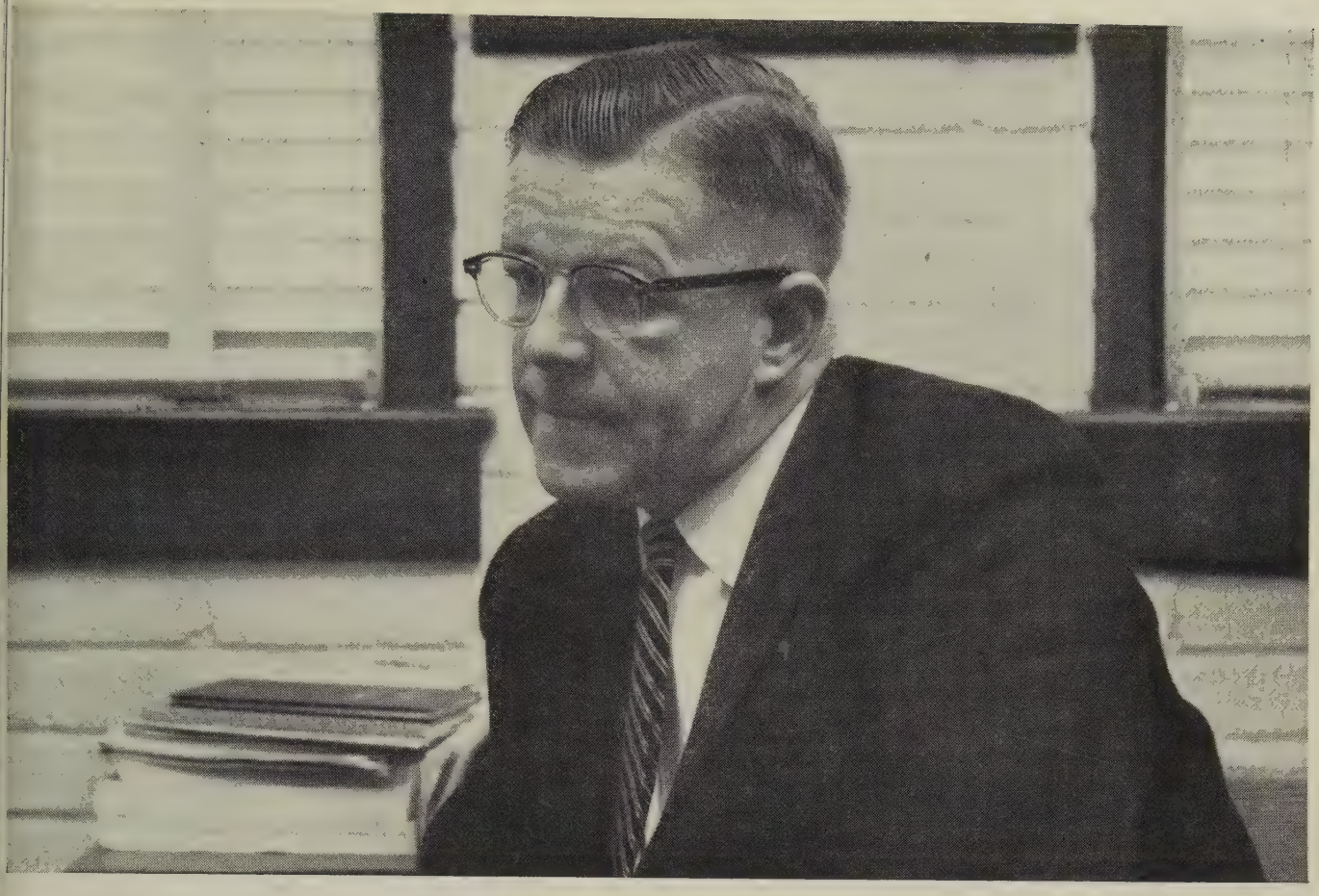
Q Are their properties well known to chemical engineers?

A Those of the first four—very much so. These chemicals have been available for a long time and much is known about them. But because each application poses certain new problems, only people who have been working with them a long time have had the experience to know just what to expect. The fifth chemical, hydroxylamine sulfate, is relatively new. Research and development are beginning to uncover what apparently are great potentialities for it.

Q Has "Virginia" helped develop applications for these reducing agents?

A Definitely. Our research and development laboratories are constantly at work looking for new applications.

Q Does your company work with manufacturers in developing new ones?



". . . by substituting zinc hydro for peroxide, they can cut operating costs . . ."

A Yes, regularly. For example, we worked in the field and in our own laboratories for several years developing uses of zinc and sodium hydro in bleaching paper pulp. The same is true of our SO_2 in pulp processing. "Virginia," incidentally, was one of the earliest suppliers of liquid SO_2 for this purpose. We spend a great deal of time with manufacturers on all phases of these operations. I could mention many such examples.

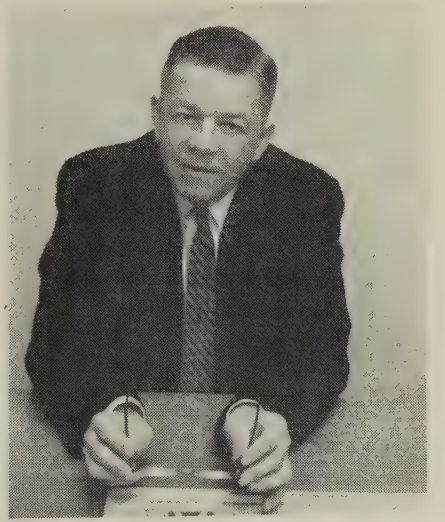
Q Do applications like these benefit other manufacturers as well?

A Yes. These reducing agent applications are rarely patented. So gradually other manufacturers begin to investigate, trying the new application out themselves. And when they discover, as they did in the paper industry by substituting zinc hydro for peroxide, that they can cut operating costs appreciably, the new operation becomes a part of their process. Until the new operation is all ironed out, our men may actually be working right in the manufacturer's plant with his engineers and chemists, helping to solve any problems that may crop up.

Q Why does the use of "Virginia" reducing agents frequently lower a manufacturer's production costs?

A For several reasons. Our products are of a very high purity in every case, but they *are* basic chemicals. So they are often not as expensive as the chemicals they replace. That's one reason. And when the manufacturer draws on the background of experience "Virginia" offers him, he is getting the benefit of every bit of technical know-how and every economical shortcut known about a given application.

Q Is "Virginia" interested in working with manufacturers on new applications, even though they are not yet customers?



"...we try to help any manufacturer who asks us."

A We are. Naturally, we are more keenly interested in some fields than others—especially where the opportunity exists to open up a large new market for one of our products. But it is impossible to be sure where such opportunities will arise, so as a matter of policy we try to help any manufacturer who asks us.

• • •

DATA AND ASSISTANCE

If you have a problem involving a reducing agent—write us on your letterhead, giving as many details as possible. We will supply you with pertinent technical literature. Or, if you prefer, we will send a "Virginia" man around to see you. No obligation, naturally.

Industrial Division
VIRGINIA SMELTING COMPANY
Dept. 357, West Norfolk, Va.

VIRGINIA® Chemicals

Field Offices: New York • Boston • Chicago • Atlanta
Asheville • Philadelphia • Akron • Seattle • Memphis

Available in Canada and many other countries

Why "Umpteen" different suppliers?

Allis-Chalmers Can Save You Time and Money with **Coordinated Engineering and Teamed Equipment**

Allis-Chalmers offers you all of these advantages:

- A broad line of mechanical *and* electrical equipment.
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- Undivided responsibility for performance.
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And, of course, having only one supplier eliminates the many conference hours, the complications of delivery and installation scheduling, the phone calls, telegrams and voluminous correspondence associated with buying from a combination of suppliers.

Get the complete story *from your A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.*

Allis-Chalmers Products for the Pulp and Paper Industry

Centrifugal pumps, rotary compressors, motors, control, Texrope drive equipment, screens, slakers, kilns, turbine-generators, condensers, switchgear, water conditioning equipment, materials handling equipment.

Texrope is an Allis-Chalmers trademark.

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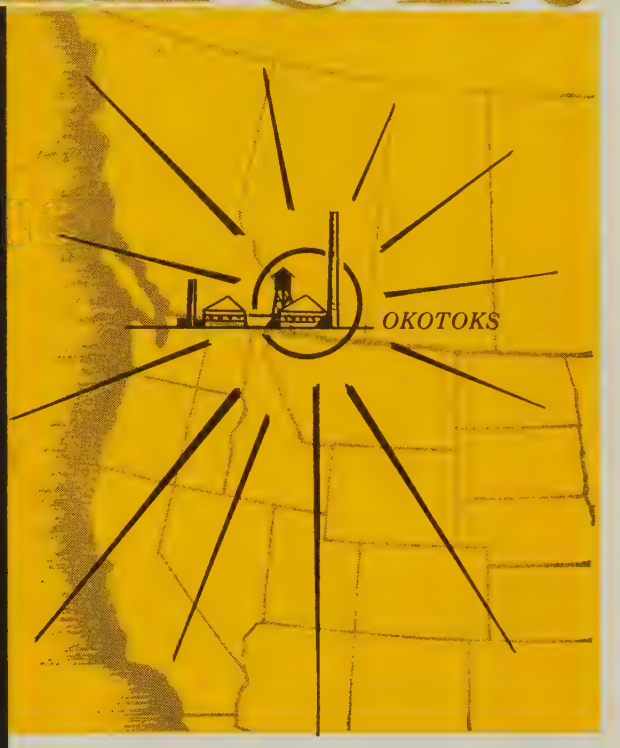
SULPHUR



OKOTOKS marks another step in the steadily broadening service being developed by TGS for industries in the States and Canada. Production from OKOTOKS, sitting on top of the vast "sour gas" field a few miles south of Calgary, Alberta, will add a significant tonnage to the supplies of Sulphur already available through TGS to the expanding industries in the Pacific Northwest. OKOTOKS is set up to make shipments of Sulphur in solid or molten form.

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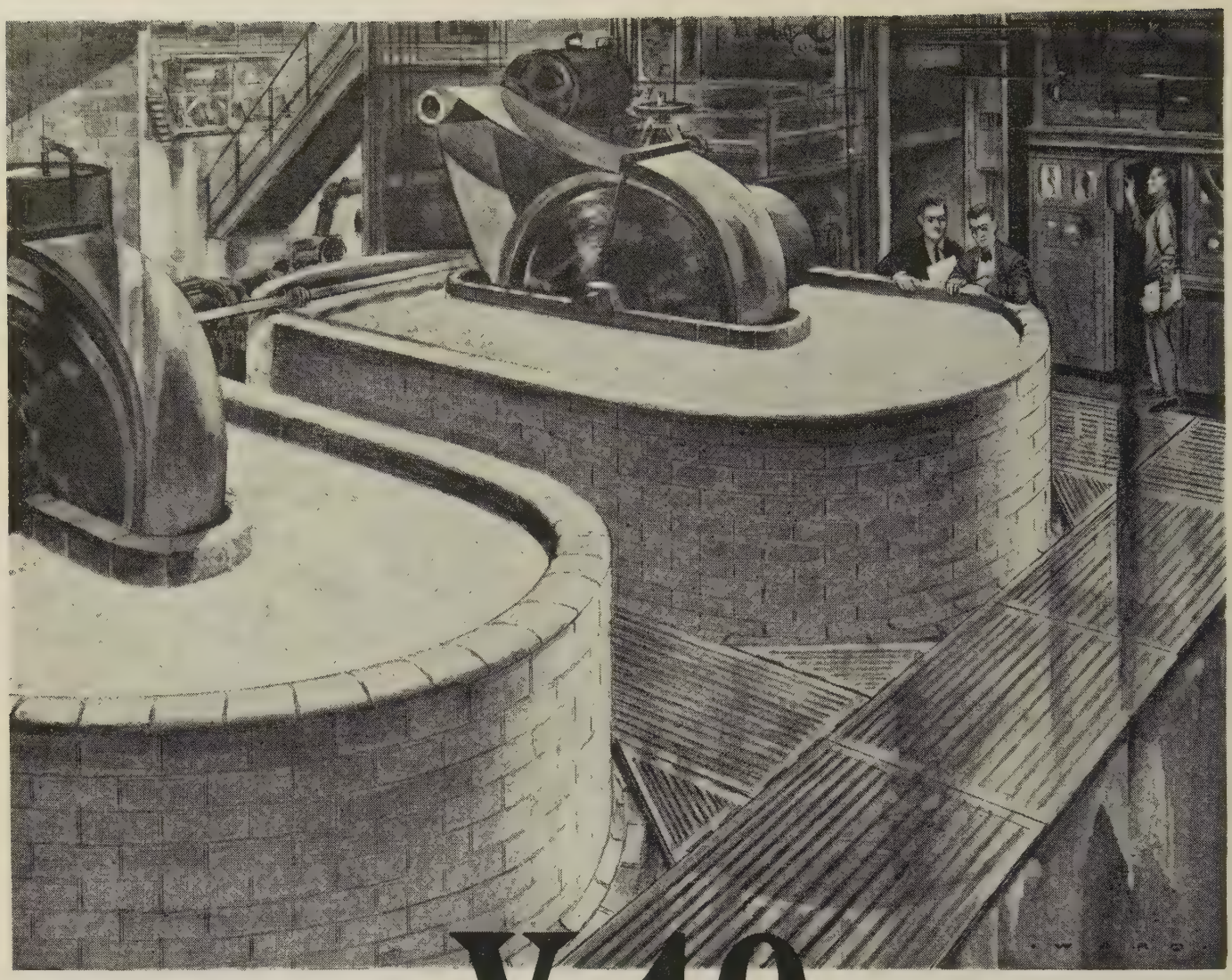


V-10 CONTROLS SLIME!

V-10 Slimacide . . . bis-1, 4-bromacetoxy-2-butene . . . ideal to rapidly rid your mill of slime problems.

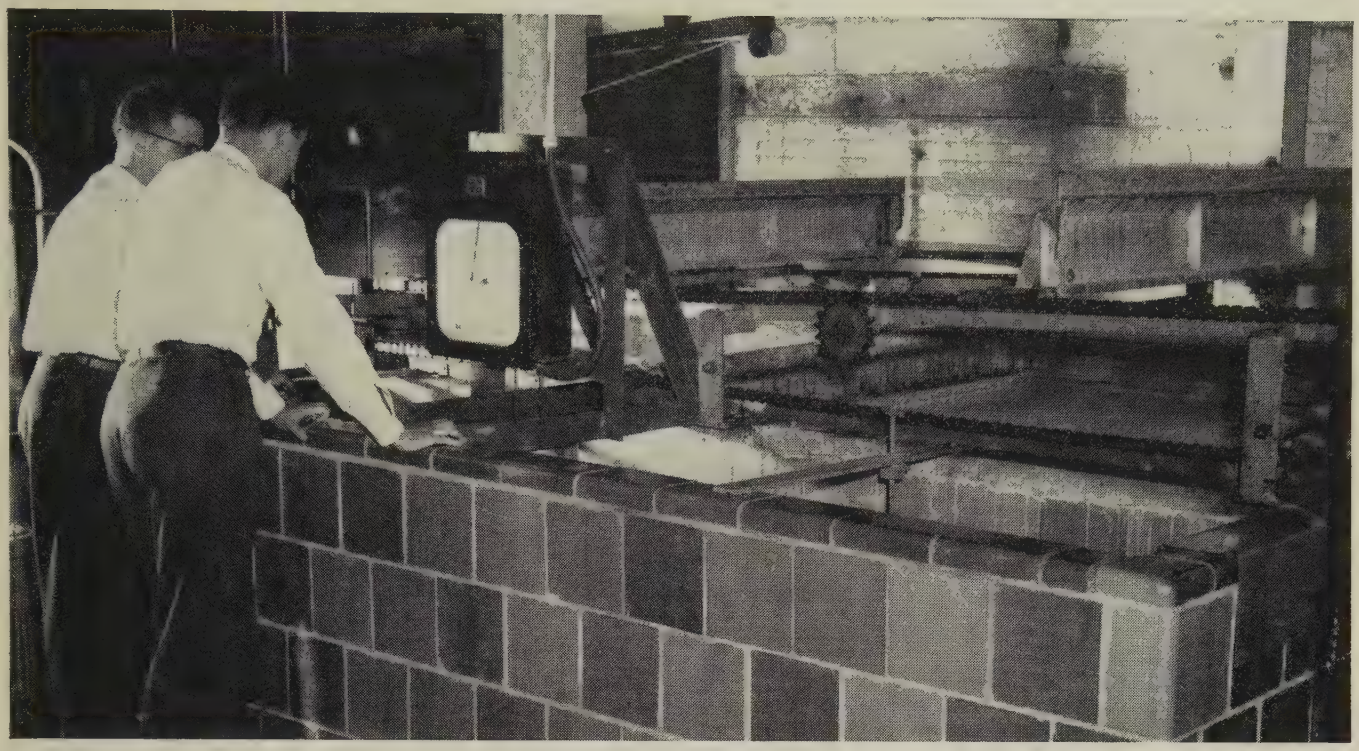
Non-toxic, odorless, economical and non-corrosive V-10 provides the perfect slime controllant. V-10 is effective at high dilution, persists for hours. Simply add once a day. Exhaustive studies * have proven V-10 safe for any ordinary use in Tissue, Wadding and Food Board mills.

V-10 SLIMACIDE offers continuous, safe and effective slime control. Helps reduce your production costs. Our technical staff is always ready to assist you in establishing slime control. Bacterial population and prevalent micro-organisms will be determined at your request without cost or obligation. Write or telephone (OX-1-3535) for free booklet, "Control of Slime in the Paper Mill."

* *Test results available on request.*

Vineland Chemical Co.
West Wheat Road, Vineland, N. J.

FLUIDICS* AT WORK



Checking clarified effluent of the Permutit Colloidair Separator at the Homasote Company

How to side-step a public health hazard ... and step into big new savings

Maybe you have a problem similar to the one that confronted the Homasote Company, Trenton, N. J.

They make high-density wood fiber insulation board. The process *could* create a waste disposal problem and impair the company's good community relations.

The answer found by Homasote turned out to be more than just a waste treatment system. It is also a valuable way to save money, through reclaimed product and water.

The Permutit Colloidair Separator is behind this accomplishment.

Saves product. White water feeds into the Colloidair, where a "bubbling-out" process raises the fibers to the surface. These fibers are scraped off and reclaimed.

Saves water. No water is wasted in this closed-circuit operation. Colloidair clarifies it for Homasote's re-use in pump glands, stuffing box seals, and for general cleanup.

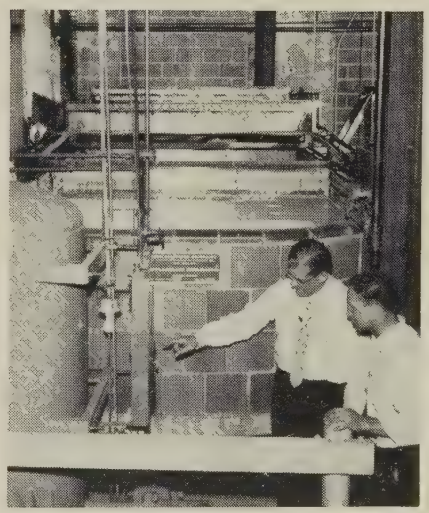
Saves heat. The reclaimed water holds most of its heat during the clarifying process. This saves the expense of re-heating for re-use.

Easy to use. Colloidair works almost by itself. The operator does little more than periodically charge chemical tanks.

Homasote is getting these benefits today . . . when would YOU like to start?

We will be glad to run lab and/or pilot plant tests to show just what the Permutit Colloidair Separator can do with your white waters and/or waste waters.

Save your public relations . . . and your money. Get more information on Colloidair by writing our Permutit Division, Dept. TA-109, 50 West 44th Street, New York 36, New York.



Observing Colloidair's chemical feed at Homasote

*FLUIDICS is a new Pfaudler Permutit program that provides a modern, imaginative approach for handling and processing liquids and gases more profitably.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . . the science of fluid processes

THIELE KAOLIN

SUPERIOR CLAYS

for FILLING or PAPER COATING

- **Controlled Particle Size** • **Excellent Color**
- **Standardized Low Viscosity** • **High Brightness**

Thiele Water-Washed Clays are mined from vast holdings in the heart of Georgia's clay belt, carefully tested and controlled while being processed at Thiele's modern plant. Two spray drying plants assure coating clays that will provide EASIER MAKE-DOWN — IMPROVED HANDLING—LOWER MOISTURE CONTENT—LOWER SOLUBLE SALT CONTENT—MORE UNIFORMITY—LOWER ABRASION.

Write for full information and sample of Thiele Kaolin Coating or Filler Clay for your particular use.

Thiele Kaolin Company

P. O. BOX 270 • SANDERSVILLE, GA.

Wet SO_2 line now in 4th year ...proves superiority of Ni-O-Nel alloy

Resists the pulp and paper industry's most troublesome corrosives

That return gas line running down between the Jenssen acid towers shown above has been working there since 1955. It is at Scott Paper Company's Detroit plant.

The line is 16 inches in diameter and 77 feet long. Yet it was put up with no intermediate supports. It needed none, because of the extra strength and rigidity that Ni-O-Nel nickel-chromium-iron alloy provides.

This line carries wet SO_2 between the towers handling weak and strong acids. It's an outstanding replacement where a previous pipe failed. Periodic inspections reveal no leaks or need of maintenance.

Remarkable resistance to severe corrosives

Ni-O-Nel alloy has demonstrated in both laboratory and field remarkable resistance to hot acids and oxidizing chemicals.

Members of the pulp and paper industry are also finding it useful in handling sulfurous-sulfuric combinations. Ni-O-Nel alloy is highly resistant to combustion gases and condensates from sulfur-bearing fuels.

For equipment used to prepare and handle digester cooking liquors it is excellent. Provides resistance to calcium, ammonium, magnesium, and sodium bisulfite. In duplex pulping involving a pre-hydrolysis reaction followed by a straight Kraft cooking process, it performs better than alloys previously used.

Ni-O-Nel alloy is made of Nickel (42%), chromium (21.5%), and iron (30%) with additions of molybdenum and copper. It is highly resistant to hot sulfuric, sulfurous and phosphoric acids and to oxidizing conditions such as nitric acid solutions, nitrates and cupric, ferric and mercuric salts, except the chlorides.

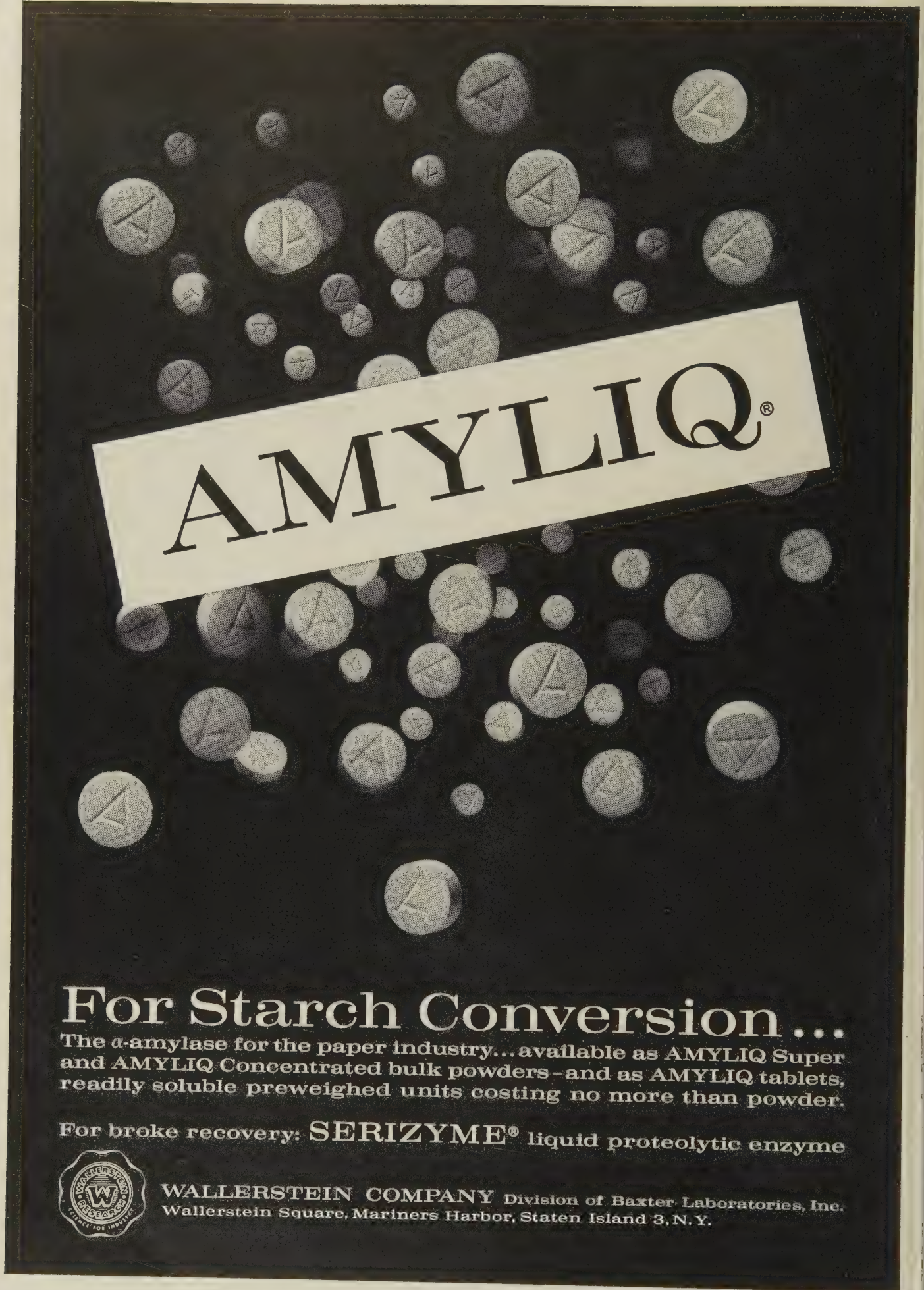
Ni-O-Nel alloy is available in sheet, plate, seamless tubing and pipe, and other mill forms needed for fabricating process equipment, including welding electrodes.

For exact composition and physical properties, for detailed data on corrosion resisting experience with this new alloy write for, "The Corrosion Resistance of Ni-O-Nel."

*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
67 Wall Street New York 5, N. Y.

NI-O-NEL®


AMYLIQ®
For Starch Conversion...
The α-amylase for the paper industry... available as AMYLIQ Super and AMYLIQ Concentrated bulk powders–and as AMYLIQ tablets, readily soluble preweighed units costing no more than powder.
For broke recovery: SERIZYME® liquid proteolytic enzyme
WALLERSTEIN COMPANY Division of Baxter Laboratories, Inc.
Wallerstein Square, Mariners Harbor, Staten Island 3, N.Y.

NEW BAILEY
Multi-Pointer Gage

...has twice as many indicators
...no taller than a telephone!

Now the popular versatile Bailey Multi-Pointer Gage has been reduced in size to conserve control panel space—without loss of easy *readability*.

Each new Multi-Pointer Gage Unit offers you these three choices to—

1. Measure and indicate draft, pressure, differential pressure and level.
2. Transmit above variables either pneumatically or electrically to remote indicators, recorders and/or controllers.
3. Receive and indicate any measured variables which may be transmitted pneumatically by standard SAMA ranges of 3-15 psig. or 3-27 psig.

FEATURES

Compact Size—Two large, easily-read 7″ scales in space only 4 inches wide.

Wide Range Selection—Standard ranges from 0-0.5 in. H_2O to 0-5000 psig available.

Choice of Standard Colors—Satin Black, Slate Gray, Moss Green, or Terra Tan may be selected as an exterior color at no additional cost.

Colored Scales—Scales available in white, red, green, blue, yellow, or orange.

Fluorescent Illumination—All gages have slideout unit containing bulb and starter for ease of maintenance.

Readily Accessible Adjustments—Zero adjustment made from front of gage. Other adjustments made from rear of gage.

Two-point Positive Mounting—Gage unit mounted with two clips . . . no holes to drill or studs to weld.

Unlimited Indications—Any number of basic two-indicator units may be placed side-by-side to provide indications of related factors. Each two-indicator unit is separately mounted.

For additional information, call your local Bailey District Office, or write us direct.

P46-1

Pulp and paper division

BAILEY METER COMPANY

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BAILEY METERS

"**Brightness is necessary** in our lightweight papers . . . opacity, too. That's why we use TiO_2—at the rate of 2 tons a day. As purchasing agent, I can't take chances on off-grade, off-quality pigment. So I order Du Pont Ti-Pure*. It comes in the exact grade we need; it's delivered when we need it. And Du Pont Technical Service has helped us out several times. And with Du Pont's expanded production, I don't have any worries about future supplies."

(Based on an actual conversation between a Du Pont Representative and a customer.)

▶ Talked to *your* Du Pont Pigments Representative lately? He'll be glad to point out the "extras" you get with Du Pont "Ti-Pure" titanium dioxide pigments. Call him today! E. I. du Pont de Nemours & Co. (Inc.), Pigments Department, Wilmington 98, Delaware. In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

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*DU PONT'S TRADEMARK FOR ITS TITANIUM DIOXIDE PIGMENTS

IT'S EC&M FOR A COMPLETE LINE OF SYNCHRONOUS MOTOR STARTERS!

FOR ALL LOW VOLTAGES AND FOR 2200-4800 VOLT POWER SYSTEMS!

Here's Why EC&M Pushbutton Automatic Starters Do The Job Better...

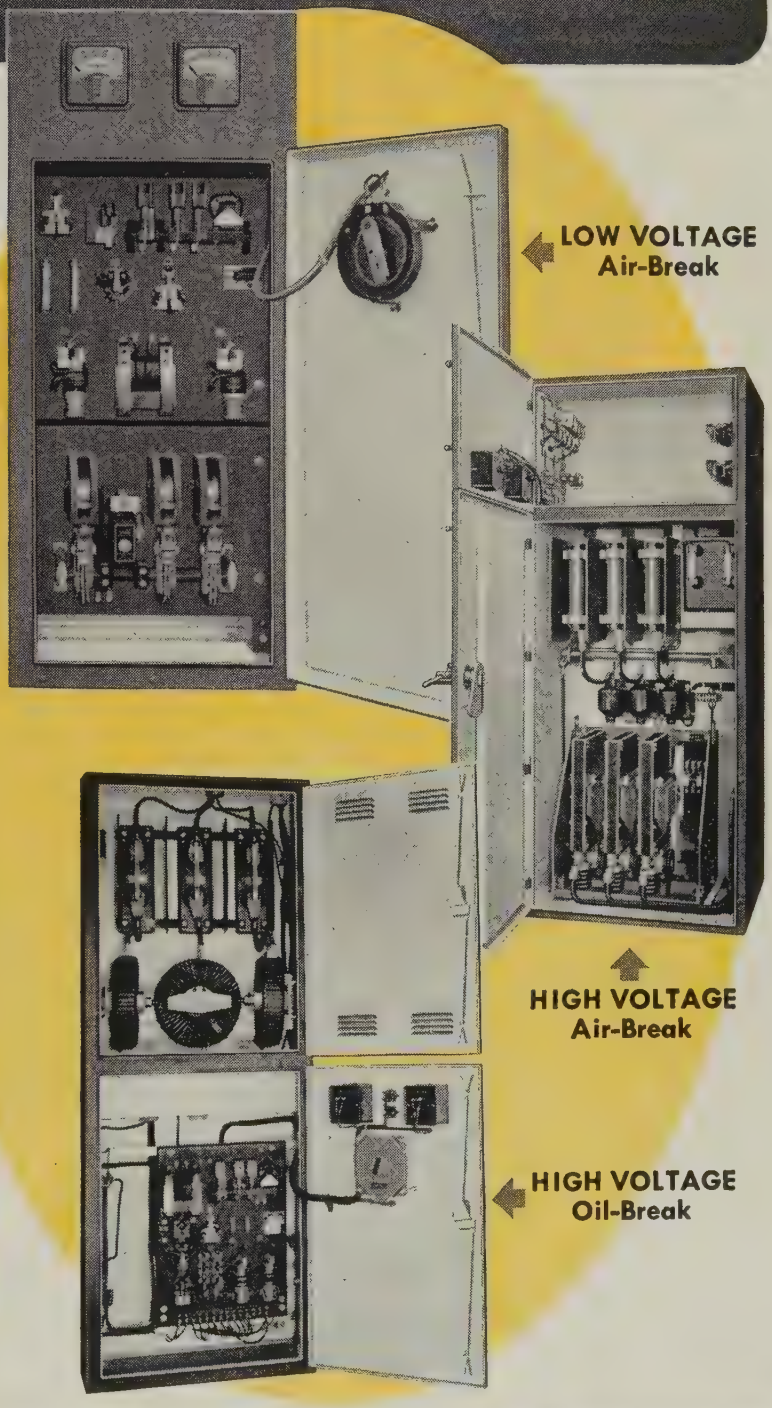
Complete protection during starting, acceleration and while running at synchronous speed.

Motor pulls into step without delay because field is applied under best conditions for synchronization.

Automatic field removal and re-synchronization allow motor to accelerate and re-synchronize after voltage dip or momentary overload.

Easily installed because all internal wiring is complete.

Full or reduced voltage starting All high voltage starters available in 3 ratings: (*1*) 50,000 KVA (certified) interrupting capacity—(*2*) with power-type, current-limiting fuses—(*3*) VALIMITOR® (volt-ampere-limitor), the bus may be of unlimited KVA.



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THE ELECTRIC CONTROLLER & MFG. CO.
A DIVISION OF THE SQUARE D COMPANY
CLEVELAND 28 • OHIO

8587

Diamond "Flow-through" chlorination cell
Diamond "Probe" chlorination cell

New "brain cells" for precision chlorination control

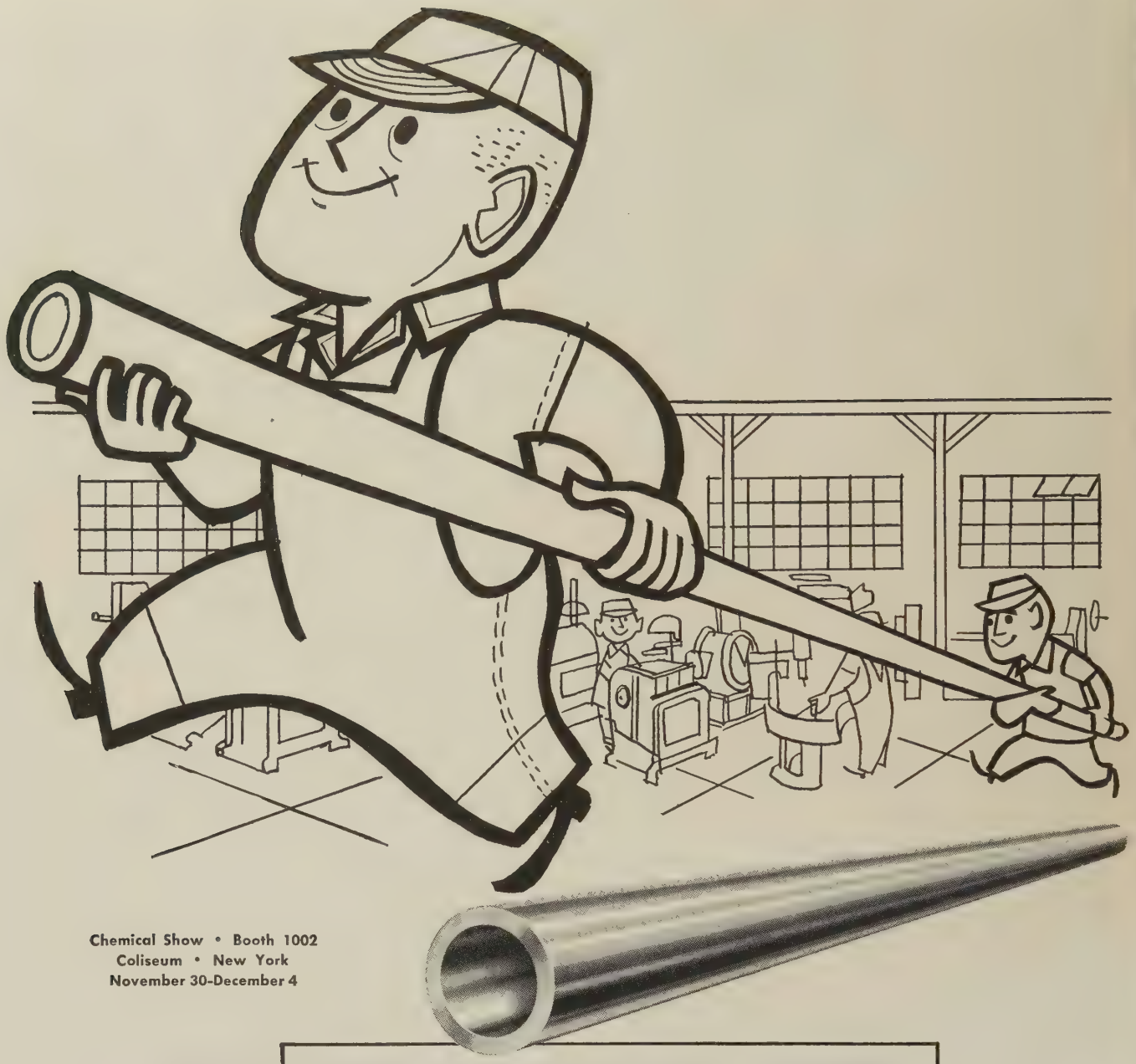
Here's another exciting new development from Diamond's customer-service research. These low-cost chlorination cells are rugged, precise, completely dependable... give you a simple means of measuring oxidation potential to control chlorine reaction in vessels or sample lines.

No other chlorination cell combines these advantages:

1. Both electrodes are in a single body.
2. Resists virtually every condition encountered in paper mills and other applications of oxidation-potential principle... including high pressures and temperatures up to 200° F.
3. Lowers routine maintenance.
4. Reduces down time of automatic control system.
5. Eliminates bridging between electrodes by fibers.
6. Eliminates need for diluting stock or for separate sampling line.

The skill of the Diamond technicians who developed this chlorination cell, the facilities of the Diamond Pulp and Paper Laboratory and thirty years of manufacturing and shipping experience of the world's largest makers of CHLORINE and CAUSTIC SODA make Diamond your logical supplier for CHLORINE and CAUSTIC SODA. Call your nearby Diamond Sales Office or write . . . DIAMOND ALKALI COMPANY, 300 Union Commerce Bldg., Cleveland 14, Ohio.

Diamond Chemicals



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November 30-December 4

How B&W JOB-MATCHED TUBING solves any stainless pressure tubing problem

When you call on B&W for your stainless tubing requirements you can get:

- . . . extra-long tubes (even 90-foot,* for example) if they are most suitable for your installation
- . . . a wide range of stainless analyses permitting a choice of the one grade best for your job
- . . . uniform mechanical properties and dimensions for ease of bending, welding or other fabrication

*manufactured by welding to obtain length

These are just a few of the reasons it pays to specify B&W Job-Matched Stainless Steel Tubing. Call your local B&W District Sales Specialist, or write for Bulletin TB-355 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

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Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

nothing equals

Piccopale

for waterproofing

Pale in color and chemically unique, **Piccopale,** a polymerized petroleum resin, is versatile in its many uses. **Piccopale Resin** is inert and heat stable, and its hydrocarbon structure assures the utmost in water and moisture resistance.

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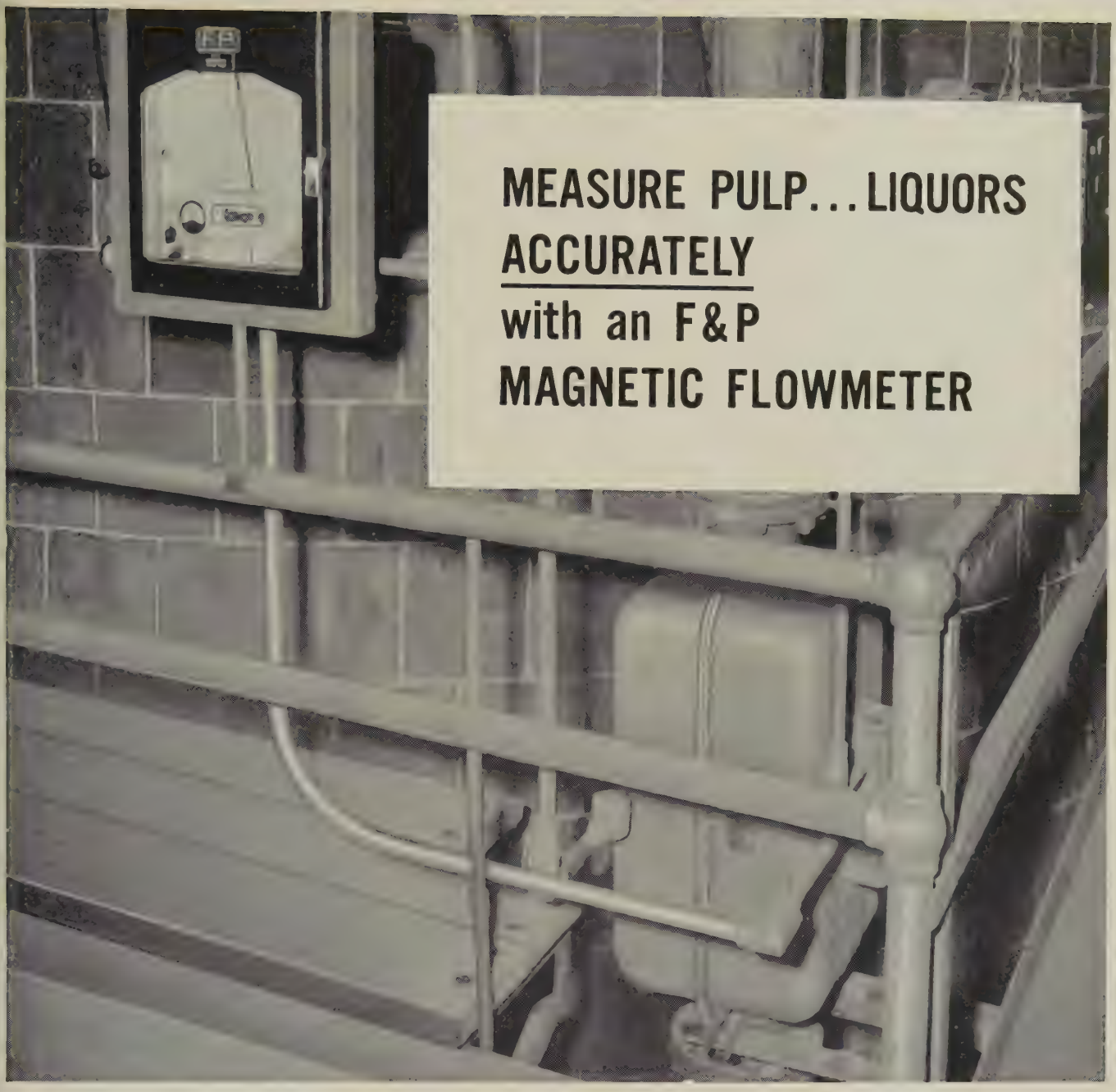
Clairton, Penna.

and all the king's men...

PULP DIVISION

WEYERHAEUSER



MEASURE PULP...LIQUORS ACCURATELY with an F&P MAGNETIC FLOWMETER

This 6-inch F&P magnetic flowmeter accurately measures stock flow at Marathon, a Division of American Can Company, Rothschild, Wisconsin.

Here's a meter that's at its best on the toughest kind of flow problems. Because it's obstructionless, F&P's *magnetic* flowmeter is ideal for pulp. No pockets, crevices, or stagnant areas where solids can collect . . . and no pressure loss.

But that's not all. Since flow through the magnetic flowmeter is essentially flow through a straight length of pipe, the meter can be lined with appropriate materials to handle the most corrosive fluids. Caustic, hypochlorites, other chemical solutions . . . and all liquors . . . there's an F&P magnetic flowmeter fitted for the toughest corrosion service in the mill.

Sizes are available to suit every flowmetering requirement, from $\frac{1}{10}$″ on up. Volume rate of flow is measured *accurately* . . . in either direction . . . independent of viscosity, density, or turbulence. You can forget about straight runs of pipe, valve placement problems, and straightening vanes.

Convenience, too! Any F&P magnetic flowmeter can be used with any of the complete range of F&P secondary instruments available. No custom matching. And any flow velocity from 1 to 30 fps can be set at full scale with a flick of a dial. Plenty of flexibility . . . plenty of room for future process expansion.

Get the facts on the F&P magnetic flowmeter Now! Contact the F&P field engineer nearest you, or write for Catalog 10D1416. Fischer & Porter Company, 1809 County Line Road, Hatboro, Pa. In Canada, Fischer & Porter (Canada) Ltd., 2700 Jane Street, Toronto, Ontario.

FP FISCHER & PORTER COMPANY *COMPLETE PROCESS INSTRUMENTATION*

DOW | COATINGS

DOW LATEX "BEEFS-UP" BOXBOARD COATINGS!

Newsboard maker gets better binder at no extra cost

A switch from casein to Dow Latex as a coating binder for boxboard has resulted in better quality board and easier processing for a large midwestern manufacturer of clay-coated board.

Here's how: By substituting Dow Latex for casein in the binder formulation, they were able to obtain a pigmented clay coating with a lower viscosity, but containing a higher percentage of solid materials.

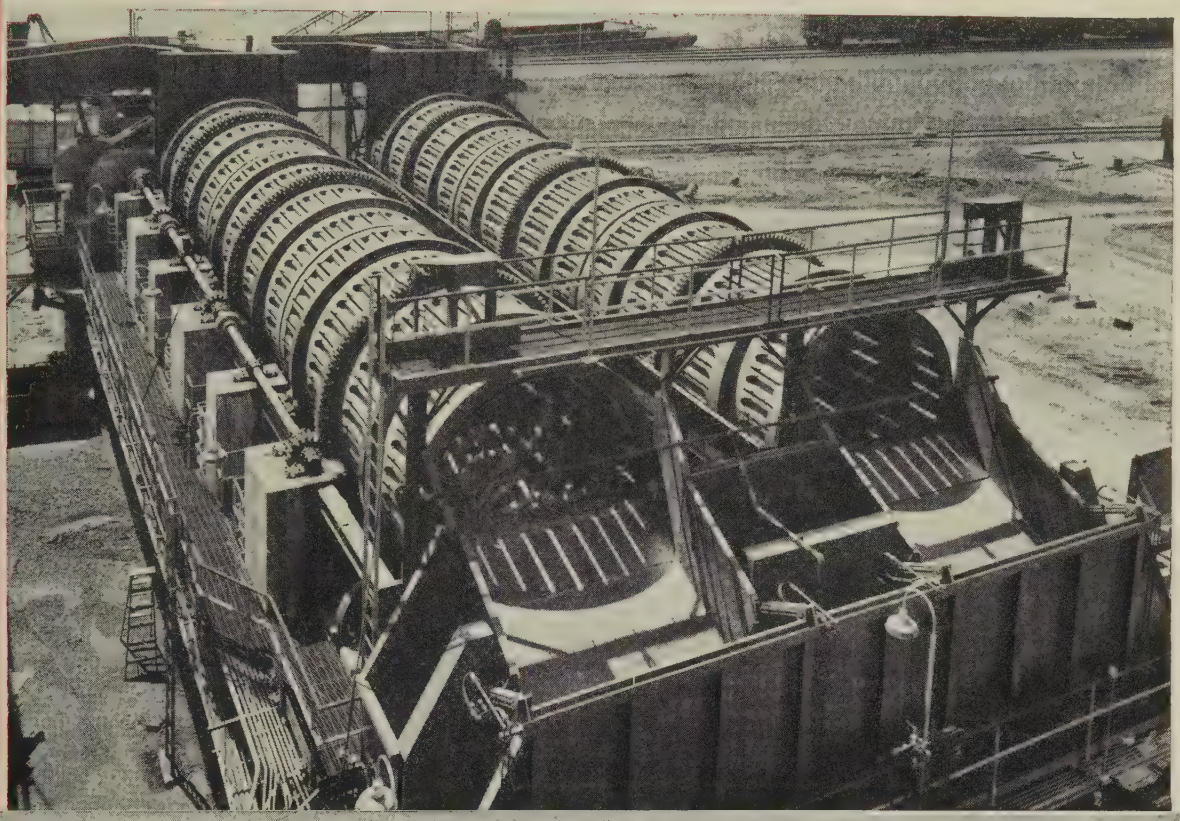
Result: Now, the new high-solids formulation with Dow Latex gives them a higher quality board with a heavier coating and better coverage—and as a result—better overall printability! The higher percentage of latex present in the coating means easier finishing on the calender — and a smoother, glossier board.

Many leading paper and board manufacturers are discovering the advantages of Dow Latex. Chances are a change to Dow Latex in the coating will make your boxboard behave better—in your production processes, and in your customer's end use. Why not contact the nearest Dow sales office, or THE DOW CHEMICAL COMPANY, Dept. 2321FC10, Midland, Michigan, for complete technical information.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGAN

The "Weldrum" Barker...

Progressive Engineering in action



These 67½ feet three-section "Weldrum" Barkers are installed at Bowaters Southern Paper Corporation, Calhoun, Tennessee.

Reducing the customer's cost of drum barking wood . . .

. . . is the primary purpose behind the design of every "Weldrum" Barker.

This continuing research may be called progressive engineering and it is done in full co-operation with the engineering staffs of our major pulp and paper producers.

Actually, our program of modifying and improving the "Weldrum" Barker has produced unparalleled savings in drum barking costs.

Four basic models cover practically all drum barking operations:

- *12′ by 45′ two-section drum for most soft woods*
- *12′ by 45′ two-section drum with solid plate inlet section for extra washing or frozen wood*
- *12′ by 67½′ three-section drum for highly resinous wood*
- *12′ by 67½′ three-section drum for hard woods*

For specific information and detailed estimates, contact your nearest Ingersoll-Rand office or write direct to Canadian Ingersoll-Rand Co. Limited, 620 Cathcart Street, Montreal, Canada.

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PROCUREMENT . . . of qualified personnel FOR mills, converters and suppliers.

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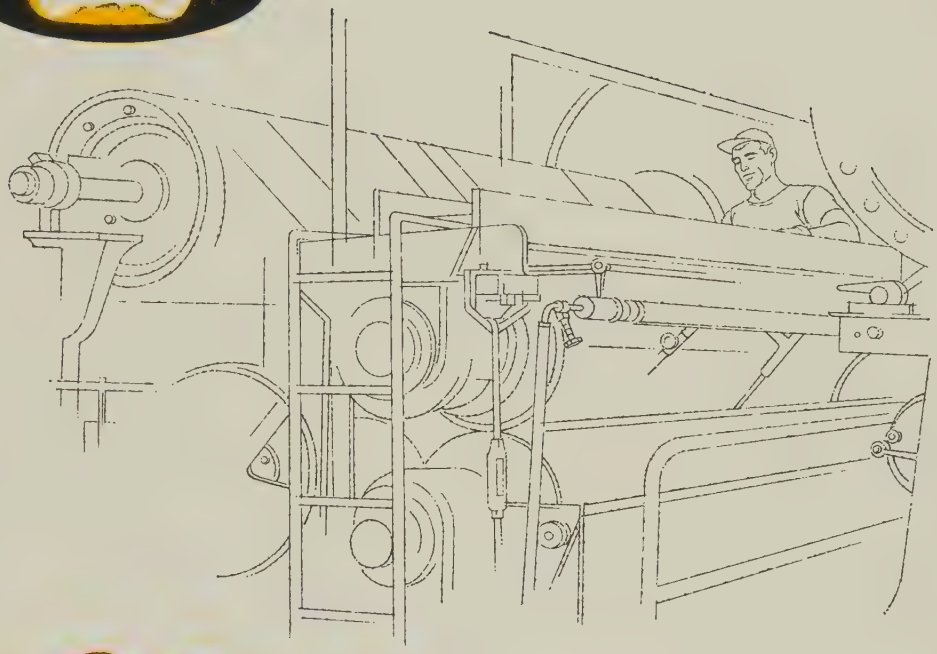

Kofilm

ACETYLATED STARCH DERIVATIVE

NEW STANDARD FOR SIZING

There's been a change. In surface sizing results. They're now much more uniform. Because KOFILM, a unique acetylated starch, eliminates variations in viscosity and strength. As proved in mill after mill in little more than a year.

KOFILM prolongs viscosity stability over extended periods of time. Performs cleanly in starch supply systems and on the paper machine. It offers high strength, more flexibility and excellent film forming properties. Produces uniform finishes and consistently high pick strengths. Improves oil resistance and wax hold out. And is an excellent pigment binder.

KOFILM is suggested for coating as well as sizing. It is available in a range of viscosities. Why not compare it against whatever you're now using? Write, telling us something of the use you have in mind.

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STARCH and CHEMICAL
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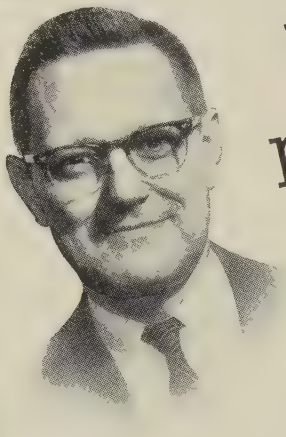
ALBANY FELT *Design* BEGINS IN YOUR MILL



Your paper machine is only as good as its felts

The finest machine in the world will go only as fast as its felts will allow.

Albany Felts get the best performance out of your machines because they're custom-designed and custom-built . . . like a made-to-measure suit of clothes that takes into consideration every individual requirement.

Your Albany Felt Sales Engineer is trained to survey your paper machine and measure its efficiency of felt application. His specialty is setting in motion Albany Felt's 4-step design service.

Working with him is a team of research, design and production experts known the world over. Together, they can help you make <u>sure</u> your machine is clothed correctly for more tons per day, more days per felt.

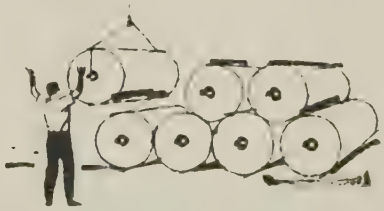
S. Stuart Engle

S. Stuart Engle,
Chief Designer

❶ **FIRST STEP IN ALBANY FELT EFFICIENCY SURVEY** is discussion of aims and operating problems by Superintendent and Albany Felt Sales Engineer, with all pertinent data recorded.

❷ **ANALYZING THE SALES ENGINEER'S REPORT,** Albany Felt Design specialists determine the felt specifications that will best solve customer's felt application problem.

❸ **DESIGN SPECIALIST REVIEWS REQUIREMENTS** with Manufacturing and Quality Control personnel.



❹ **RESULT: MAXIMUM FELT LIFE AND MAXIMUM DAILY PRODUCTION!**

ALBANY FELT COMPANY

Main Office and Plant: Albany, N. Y.

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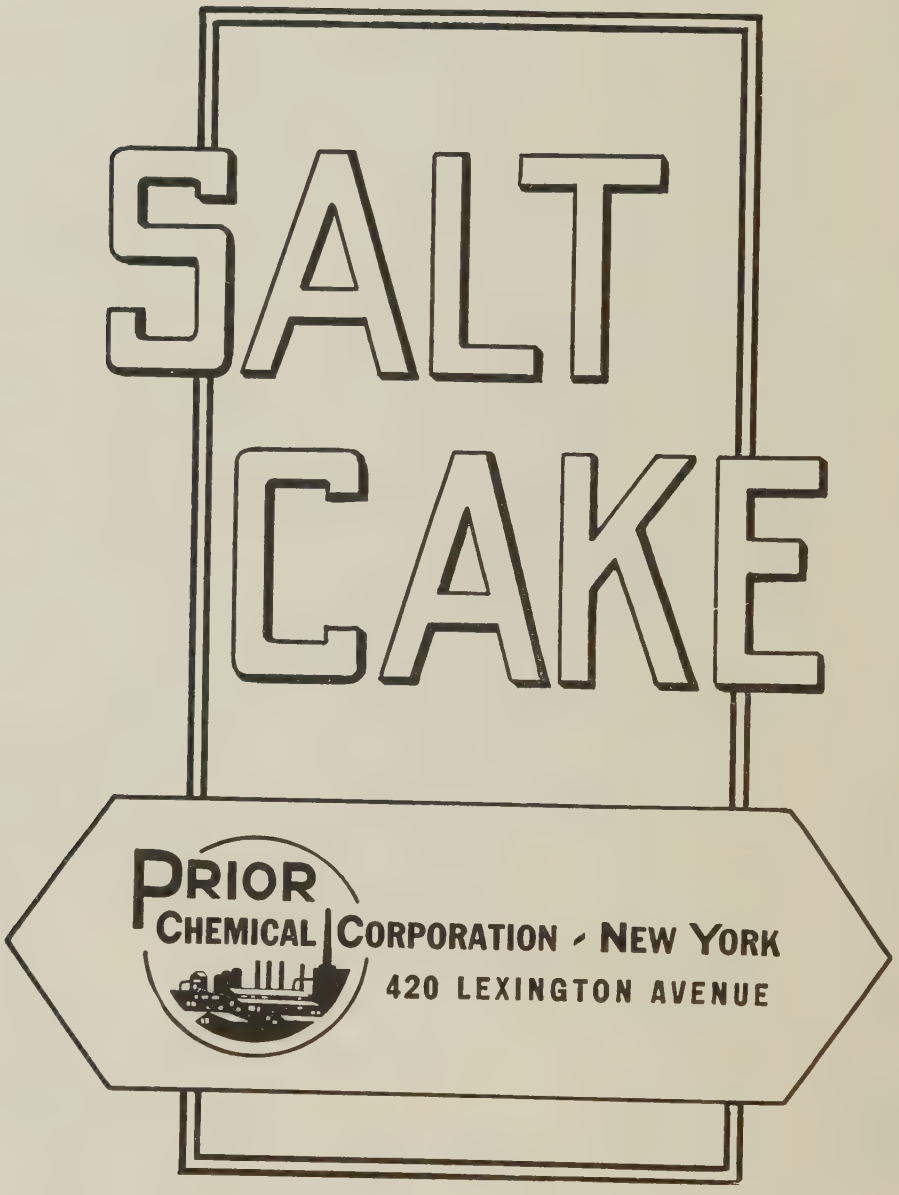
THE WORLD'S LARGEST MAKER OF PAPER MACHINE FELTS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CHEMICAL CORPORATION - NEW YORK
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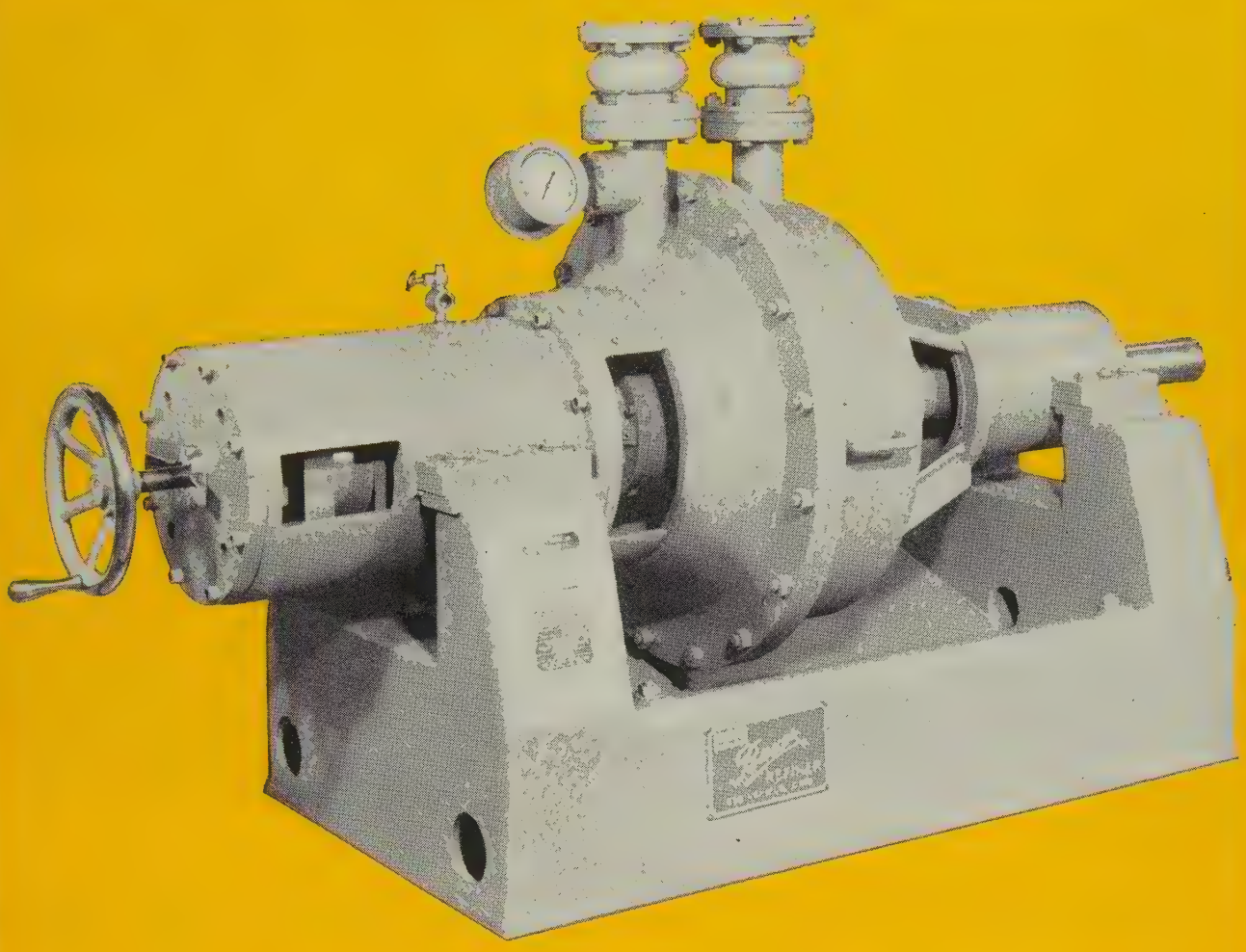
A NEW 24" BAUER PUMP-THROUGH REFINER



FOR SMALL TO MEDIUM TONNAGE MILLS

A high capacity, slow speed, single revolving disc mill designed specifically to replace jordans.

- Unequalled for stock preparation
- Pulp capacity — Up to 50 T/D
- Degree of refining accurately and easily controlled
- Automatic or remote control optional
- Low operating and maintenance costs
- Wide range of uses

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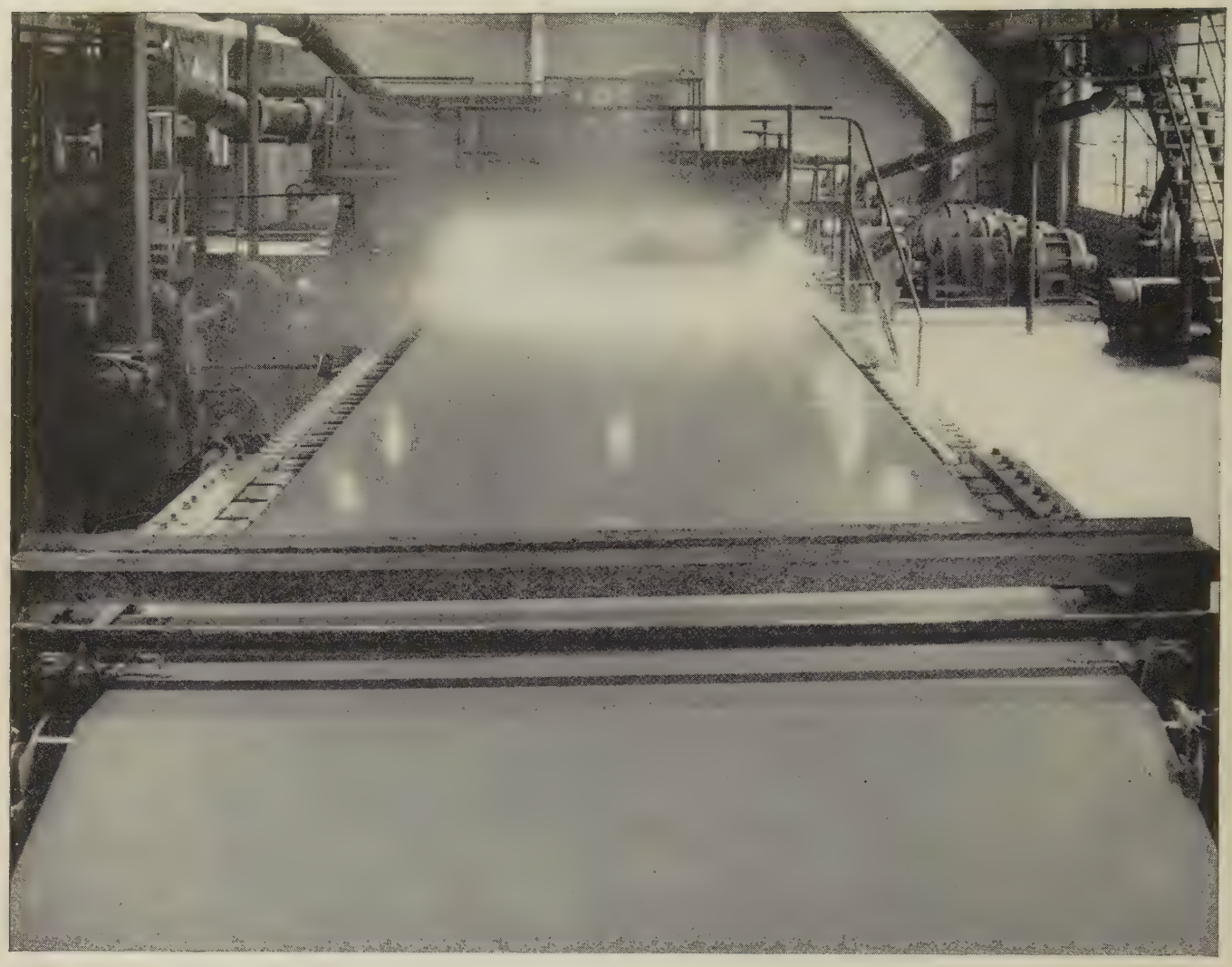
THE BAUER BROS. CO., 1757 Sheridan Ave., Springfield, Ohio



A Complete Starch Line... *tailor-made to your needs*

Today's complex papermaking operations require a wide range of starches—starches specifically designed to do a particular job. You'll find that the complete starch line offered by Corn Products Company includes types for every phase of modern papermaking. These starches are available in so many varieties that *they can literally be tailor-made to suit individual requirements* and production problems of individual plants!

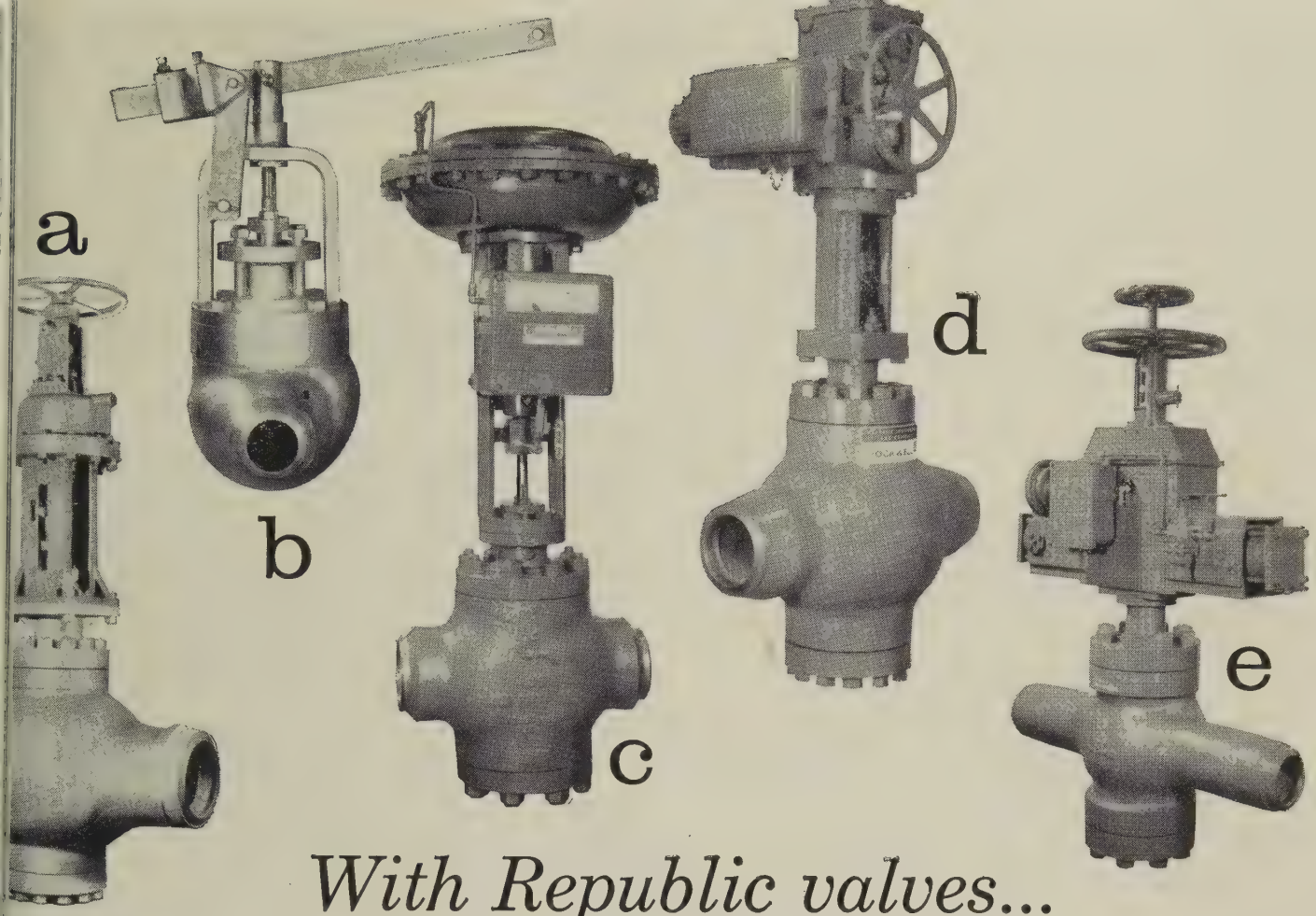
For example, in beater sizing, preferred starches for improved surface qualities plus excellent bursting and tensile strength, include the many varieties of Globe and pre-cooked Amijel. For calendar sizing, you'll find a complete line of Claro and Eagle starches, as well as Globe starches for enzyme conversion. In this operation, Globe and Excello dextrines and thin-boiling Foxhead starches are also used. For general coating, with good viscosity at high solids content, use Claro and new improved Ten-O-Film starches.

And the research staff of Corn Products Company, largest in the industry, is constantly at work developing new products to meet the changing needs of modern papermaking.

Our technical representatives are completely versed in the problems that arise with wet end additives. Their impressive field experience and continuing research into starch, evidenced by frequent publications in trade and technical journals*, is always at your service. Take full advantage of the facilities and experience of the world's largest corn processors—call our nearest sales office or write direct.

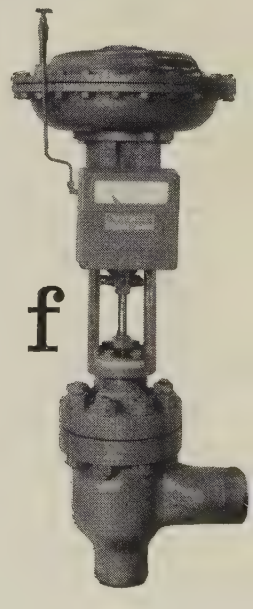
Fine products for the Paper Industry: GLOBE® • EAGLE® • FOXHEAD® • CLARO® • AMIJEL® CORAGUM® • TEN-O-FILM® starches • GLOBE® • EXCELLO® • LAM-O-DEX® dextrines and gums.

CORN PRODUCTS SALES COMPANY 17 BATTERY PLACE, NEW YORK 4, N.Y.



With Republic valves...

You get longer life, less maintenance



For over 35 years Republic valve developments have paced the changing demands for more sturdy valves by the most progressive utilities and industries. For such services as pump recirculation control, feedwater regulation, steam pressure reducing and high pressure water control, Republic valves have established a reputation for durability, long life and trouble-free performance.

Superior valve design—Republic research into the causes of valve noise and vibration, and also the wear resisting and galling properties of materials has resulted in a modern line of Republic valves of advanced design. Republic valve contours are designed to produce not only the desired regulating characteristics but also to reduce erosion damage and noise as well. Extra large guide bushings, extra deep stuffing boxes, solid plug inner valve construction, plus precise manufacture and long-life materials make Republic regulating valves perform better, last longer, with less maintenance.

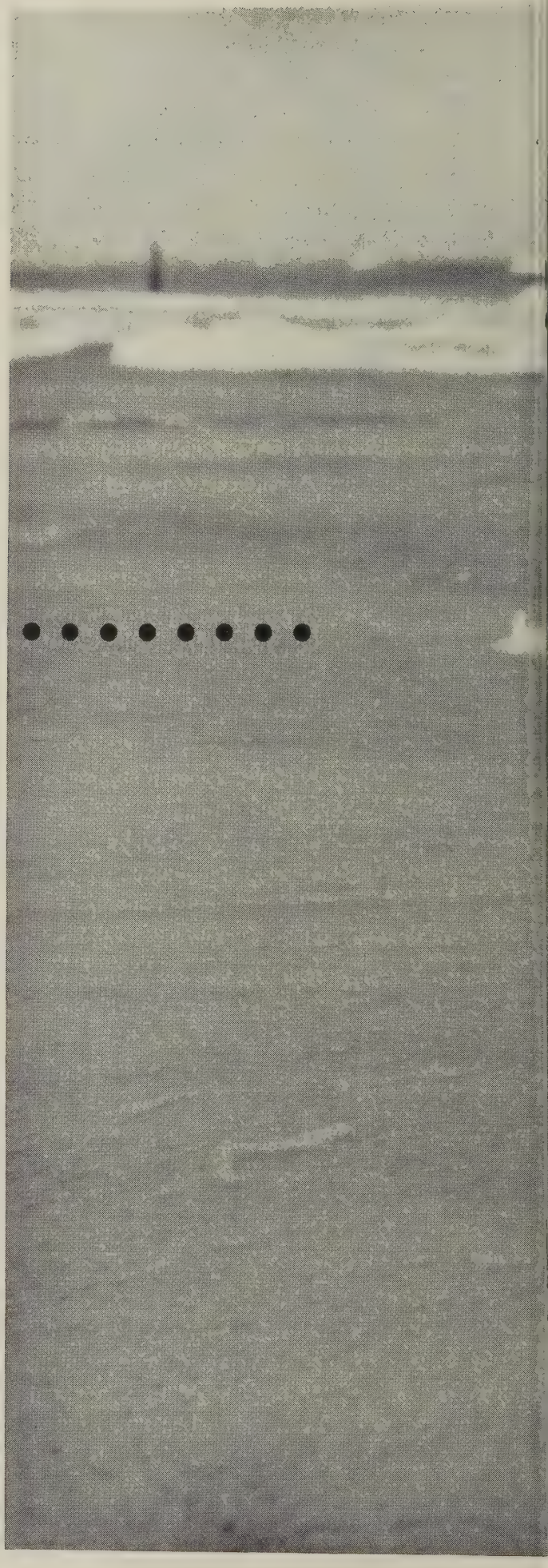
Wide selection of valves and features—Rockwell-built Republic regulating valves shown on this page are representative of the complete Republic line:

a. **Cylinder operated valve**
b. **Lever operated valve**
c. **Diaphragm operated valve**
d. **Motor operated valve**
e. **Toggle head operated valve**
f. **Diaphragm operated angle valve**

And, for many special applications, such Republic accessories as pneumatic and electric valve positioners for hysteresis-free control, and a complete line of controllers are available.

Whatever your regulating valve problem, let Republic engineers put their years of application experience to work for you. For additional information, see your Republic representative, or write to Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL



Foam is fun.....

but not for paper coaters

Koppers has just developed DYLEX® K-54 latex for paper coaters—a brand new latex, when agitated, produces a minimum of foam which dissipates at a rapid rate. A critical series of tests between DYLEX K-54 and other competitive latices has proved this conclusively.

And that's not all, DYLEX K-54 offers *improved pick resistance*, whether in combination with starch or casein. What's more, clay coatings made with DYLEX K-54 have a higher degree of smoothness and excellent mechanical stability.

Want the complete story? Then read our new detailed pamphlet on DYLEX K-54—complete with charts and test data. Write Koppers Company, Inc., Plastics Division, Dept. T-109, Pittsburgh 19, Pennsylvania.

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KOPPERS PLASTICS

KOPPERS®

They're both blowguns, but...

each is in a class by itself . . . like Wyandotte's PURECAL® O

The *method* of use is the same for a pea shooter or a blowgun . . . but one is used in fun, and the other in deadly earnest. Makes all the difference in the world when you're on the receiving end!

In calcium carbonates, it's the *method* that makes the difference. And Wyandotte PURECAL O — the calcium carbonate that's in a class by itself — is precipitated by a special process which consistently yields agglomerate-free particles of cubical shape. It is a product of exceptional purity, uniformity, and whiteness.

One result: With PURECAL O, it is possible to prepare high-solids pigment slips that retain the low viscosity so essential to successful high-speed "on-the-machine" coating.

And PURECAL O offers you countless other advantages because of its unique physical properties. A thorough evaluation in your own laboratory will bring them to light — so write for samples and technical data, today. *Wyandotte Chemicals Corporation, Dept. 756-T, Wyandotte, Mich. Offices in principal cities.*

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MICHIGAN ALKALI DIVISION

PACING PROGRESS WITH CREATIVE CHEMISTRY

In Germany as well as in the U.S.A... papermakers use and like

ALBACEL & ASTRACEL

CHLORINE DIOXIDE BLEACHED SOFTWOOD SULPHATE

CHLORINE DIOXIDE BLEACHED HARDWOOD SULPHATE

Balanced Paper-Grade Pulps Created by Papermakers for Papermakers

Throughout the free world, papermakers use and like Riegel's Albacel and Astracel . . . paper-grade pulps that provide the right balance of all important qualities... brightness, cleanliness, strength, formability and proper beating characteristics.

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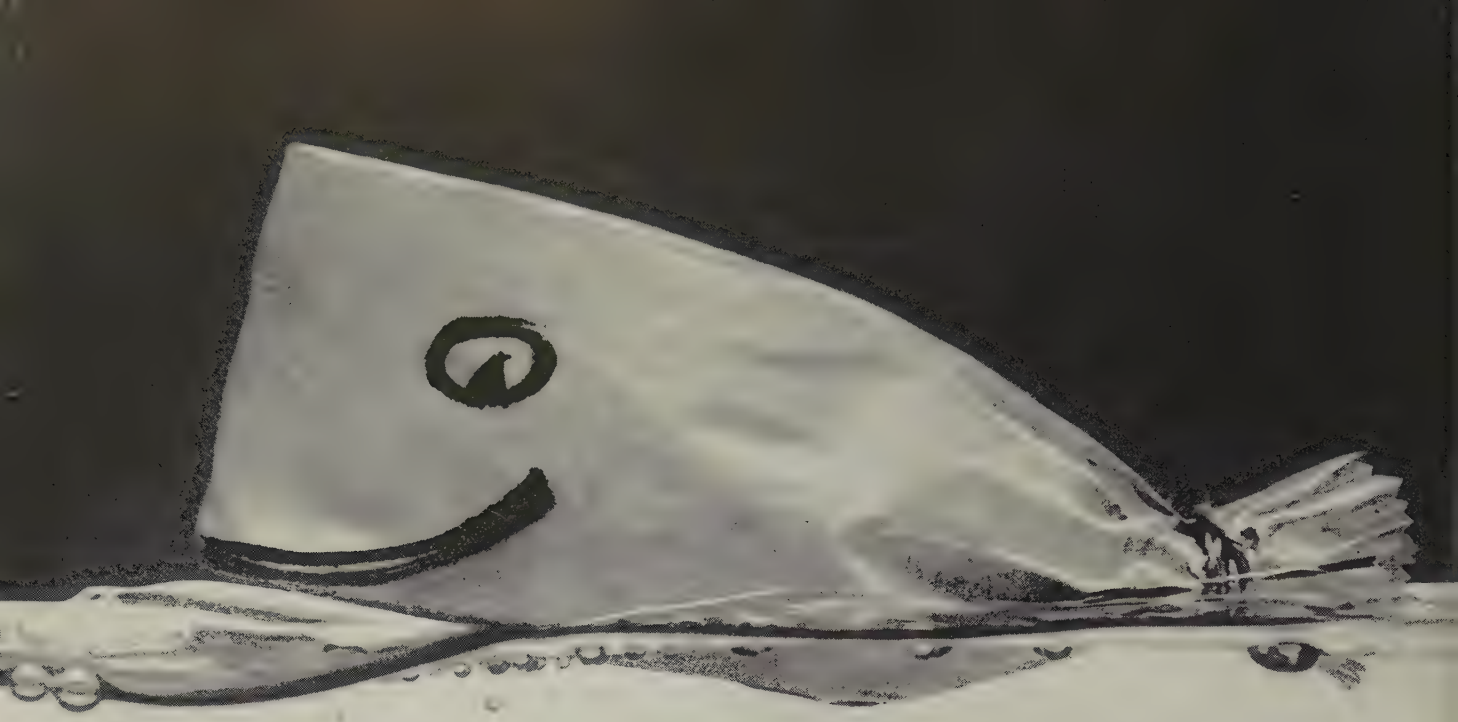

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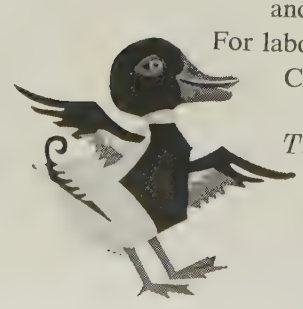

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Pulpwood Characteristics of Black Hills Ponderosa Pine

E. F. LANDT and R. O. WOODFIN, JR.

Pulpwood characteristics were determined from trees cut on 39 plots located throughout the Black Hills and Bear Lodge Mountain area of South Dakota and Wyoming. These trees, marked according to the prevailing procedure, ranged from 6.0 to 12.9 in. d.b.h., and from 19 to 77 ft. high. All bolts from a plot were measured and stacked to get cord equivalents (128 cu. ft.). Bolts from 13 plots were peeled, measured, and restacked to get a direct comparison of cord equivalents for rough and peeled wood. The stacks from timber stands 51 to 100 yr. old contain, on the average, 59% wood (75.9 cu. ft.), 19% bark (24.3 cu. ft.), and 22% airspace. In contrast, a cord of peeled wood contains 75% wood (96.1 cu. ft.), and 25% airspace. A rough green cord from these stands weighs 4950 lb. (includes 560 lb. of bark), and a peeled green cord weighs 5560 lb. A considerable drop in weight of the peeled cord takes place when it is allowed to air-dry. An air-dry peeled cord weighs 2620 lb. and contains about 550 lb. more wood than a rough cord.

An estimated two million cords of ponderosa pine pulp wood are available for harvest in the Black Hills and Bear Lodge Mountain area in South Dakota and Wyoming. The total annual growth within the area is about 120,000 cords. At present, about 25% of this annual growth is being used for posts, poles, and pulp wood. Because there is a potential demand for this raw material as pulp wood, an investigation was made to determine characteristics of the stands, trees, and bolts as a source of pulp wood. Suitability of this wood for both groundwood and kraft pulp has been established (*1*, *2*).

METHODS

Thirty-nine ponderosa pine stands were sampled in the Black Hills and adjacent Bear Lodge Mountains. These samples were distributed to include major soil and site conditions. Also, the samples were stratified by three stand conditions: (a) 51 to 100 yr. old and thinned 20 to 25 yr. ago, (b) 51 to 100 yr. old but not thinned, and (c) 101 yr. or older, often called yellow-bark stands.

Individual stands were marked according to present Forest Service practices (*3*) because roughly two-thirds of the potential pulp wood is on the Black Hills National Forest (*4*). This marking system is designed to favor sawtimber production; accordingly, trees for pulp wood would come largely from thinnings. Character of the stand determined actual area of the sample plots marked. The objective was to mark enough trees (6.0 to 12.9 in. d.b.h.) to produce about $1^1/_2$ rough cords from each sample plot.

All marked trees on the individual, rectangular sample plots were measured at breast height, felled, cut into 100-in. bolts and stacked. Measurements made immediately after felling included: total height, height to 4-in. d.i.b., number of 100-in. bolts per tree to a 3.5 in. top d.i.b., d.o.b., and d.i.b. at each end of bolt. All bolts from an individual plot were stacked in a portable rack of known dimensions to get actual cord volume (Fig. 1). On 13 plots representing average growing conditions (*3*) the stacks were broken and each bolt peeled, restacked, and again cord volume was computed. Proportion of wood, bark, and airspace per cord for rough and peeled wood was then calculated. All cord computations in this study were based on 128 cu. ft., although bolts were 100 in. long.

Specific gravity, growth rate, moisture content, and defect were measured on an additional four randomly selected trees from each of the 39 plots. Disks 1 in. thick, cut at 100-in. intervals from stump height to 3.5 in. d.i.b. were the basis for these determinations. From each of these disks, wedge-shaped pieces were cut and used for specific gravity (green volume) and moisture content determinations.

RESULTS

Pulp wood characteristics within age classes were often the same from plot to plot, even though plots had been located to sample site variations, including effect of thinning. For example, trees per rough cord, specific gravity, and wood per cord were similar for both thinned and unthinned stands. However, bolts per cord differed between thinned and unthinned stands. In only a few instances were properties of the yellow-bark stands (101 yr. +) similar to those of the younger stands (Table I). Pulpwood characteristics to be reported refer to those trees to be removed as pulp wood and not to the stands as a whole.

Fig. 1. Pulpwood sample cut from thinned stand (51 to 100 yr.) in background. This sample contains 1.62 rough cords, 120.6 cu. ft. solid wood, and 63 bolts

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Table I. Average Tree and Stand Characteristics—Black Hills Ponderosa Pine, Pulpwood-Sized Trees

Stands	D.b.h., in.	Tree height: Total, ft.	Tree height: To 4-in. top d.i.b., ft.	Bolts/tree, ft.	Bark: Vol./tree, %	Bark: Wt./tree 3.5-in. top d.i.b., lb.	Growth rate, rings per in.	Age, yr.	Trees/rough rough card,[b] no.	Rough cords/acre,[c] no.
Thinned (age 51 to 100)	8.2	43.4	27.1	3.0	25.3	39	17	72	15.1	8.4
Unthinned (age 51 to 100)	7.6	44.6	26.2	3.0	23.6	32	18	66	17.1	8.7
Yellow-bark (age 101+)	8.4	50.7	34.3	4.0	21.3	45	32	129	11.3	10.9
Differences between means (significant at 5% level)[a]	a & b b & c	a & c b & c	a & c b & c	a & c b & c	a & c b & c	b & c	a & c b & c	a & c a & c	a & c b & c	a & c b & c

[a] (a) Thinned; (b) unthinned; (c) yellow-bark.
[b] The values are based on a 128 cu. ft. cord (4 by 4 ft. by 96 in.). To find the number of trees in a 133 cu. ft. cord (4 by 4 ft. by 100 in.) multiply the number of trees by 1.04.
[c] Based on sample plots 0.05 to 0.5 acre in size and are estimates only. The values ranged from 3 to 28 cords per acre.

Tree Characteristics. Trees in the yellow-bark stands were generally larger in diameter and height than younger trees. In turn, these older trees averaged four 100-in. bolts compared with three such bolts for the younger age class. Consequently, fewer yellow-bark trees were needed per rough cord. The yellow-bark trees were not only older but also had grown more slowly than had the younger age class. They were also found to have thinner bark and hence less total bark volume; nevertheless, they had more pounds of bark per tree because they were larger. Tree characteristics for the three stands are listed in Table I.

Tree characteristics of the stands that had been thinned 20 to 25 yr. ago by the Civilian Conservation Corps were similar to the unthinned stands except for diameter breast high. However, the average diameter breast high of the thinned stands was only 0.6 in. greater than the unthinned stands. Differences in height growth were not significant and trees in thinned and unthinned stands averaged three bolts.

Both the thinned and yellow-bark stands had the greatest number of trees in the 6-in. class even though the average diameters 7.6 and 8.4 differed significantly. In contrast, the thinned stand had the greatest number of trees in the 7-in. class (Fig. 2). The bulk of the trees fell into the 6.0 to 8.9 d.b.h. range. Observations on even-age stands throughout the Black Hills indicate that most of the available pulp wood will also fall in this range.

Defect was not serious. Less than 1% of the total wood volume sampled was infected with western red rot.

Wood Characteristics. The wood of the young trees had a specific gravity of 0.398 and an average moisture content of 133% compared with 0.417 and 111% for the older age class trees. However, due to the higher moisture content, the green weight of the wood of the young trees was greater than the weight of the older age class trees (Table II). The younger trees had larger amounts of sapwood than the older trees and had moisture contents as high as 154%, but in yellow-bark trees with lesser amounts of sapwood the moisture contents were as low as 84%. These values are based on moisture-free wood. Also they are for summer-cut trees and are not expected to be greatly different from moisture contents of winter-cut trees (*5*).

Only a small proportion of the total wood volume (3%) was identified as compression wood. A slightly greater amount of compression wood (5%) was found in wood from the unthinned young stands, with 2% from both the thinned and yellow-bark stands.

Stacking Characteristics. Volume measurements of individual bolts in rough and peeled piles were used to compute cubic feet contents per cord. Although 100-in. bolts were cut, all cord volumes were based on 128 cu. ft. Since average values for both age classes were not significantly different they were combined—75.9 cu. ft. of wood per rough cord and 96.1 cu. ft. per peeled cord (Table III). However, the average bark volume per cord was greater in the younger age class—24.3 compared with 20.9 cu. ft. The proportion of wood, bark, water, and airspace in a cord from the younger age class is shown in Fig. 3. The 75.9 cu. ft.

Table II. Wood Characteristics—Black Hills Ponderosa Pine

Stand age,[a] yr.	Sp. gr. (green volume)	Weight of wood, lb. per cu. ft.: Moisture-free	Weight of wood, lb. per cu. ft.: Air-dry (10% MC)	Weight of wood, lb. per cu. ft.: Green (when cut)	Moisture content (when cut), %	Volume, %: Heartwood	Volume, %: Sapwood
51 to 1000	0.398	24.8	27.3	57.9	133	3.6	96.4
101+	0.417	26.0	28.6	54.9	111	16.1	83.9

[a] Stand differences for all items are significant at the 5 or 1% levels.

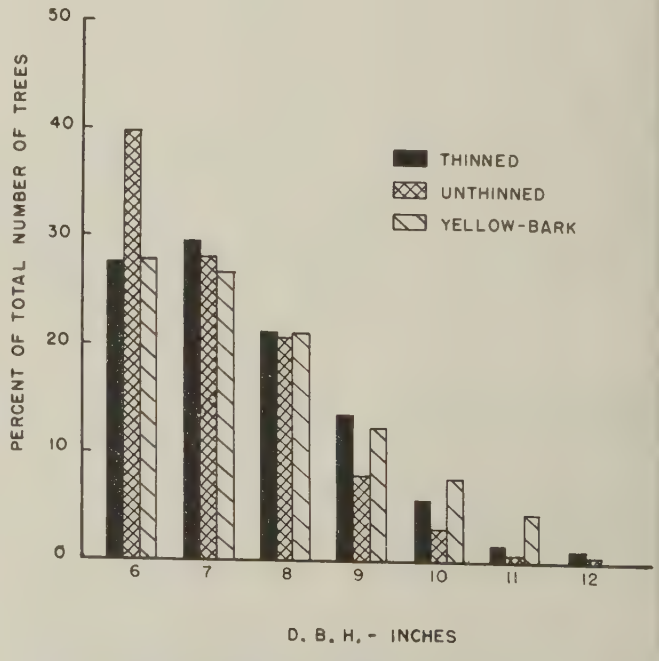

Fig. 2. Distribution of Black Hills ponderosa pine trees marked on 39 plots

Table III. Characteristics of an Average Cord[a] of Black Hills Ponderosa Pine Stacked in 100-In. Bolts

Stand age, yr.	Bolt condition	No. of bolts	Wood, cu. ft.	Bark,[c] cu. ft.	Wood + bark green, lb.	Wood, lb.			Bark green, lb.
						Green	Air-dry	Moisture-free	
51 to 100	Rough	42[b]	75.9	24.3	4950	4390	2070	1880	560
	Peeled	55	96.1	0	...	5560	2620	2380	0
101+	Rough	41	75.9	20.9	4690	4170	2170	1970	520
	Peeled	58	96.1	0	...	5280	2750	2500	0

[a] The values are based on a 128 cu. ft. cord (4 by 4 ft. by 96 in.). To find the volume and weight properties of a 133 cu. ft. cord (4 by 4 ft. by 100 in.) multiply the table values by 1.04.
[b] Thinned stands only, number of bolts for unthinned stands is 48 and 66, rough and peeled, respectively. The volume and weight properties were combined for thinned and unthinned stands.
[c] Removal of bark resulted in an average of 20% shrinkage of stack volume from a rough to a peeled stack for both age classes.

of wood is 59% of the volume of a rough cord and 96.1 cu. ft. is 75% of the volume of a peeled cord. The greater number of bolts in a peeled cord accounts for this increase in wood volume.

Weight per cord is greater for the older age class than for the younger except for green wood. The younger trees have a higher moisture content because of a greater amount of sapwood. As a result, green weight per cord is 4950 lb. compared with 4690 lb. for the older age class (Table III). However, when weights are based on air-dry (10% m.c.) or moisture-free conditions, the older stands yield a greater amount of wood; the weight for a peeled cord from older stands is 2500 lb. compared with 2380 lb. for young stands, on a moisture-free basis.

DISCUSSION

Pulpwood requirements per ton of pulp were about 20% less for peeled wood than for unpeeled wood. Thus sulphate pulp with 48% yield (*6*) would require 2.0 cords of unpeeled wood per ton of air-dry pulp compared with 1.6 cords of peeled wood. Groundwood pulp requirements with 95% yield (*6*) would be 1.0 rough cord or 0.8 peeled cord per ton of air-dry pulp. To produce 200 tons of air-dry kraft pulp would require 400 cords of rough or 320 cords of peeled wood. The same amount of groundwood pulp would require 200 cords of rough wood or 160 cords of peeled wood.

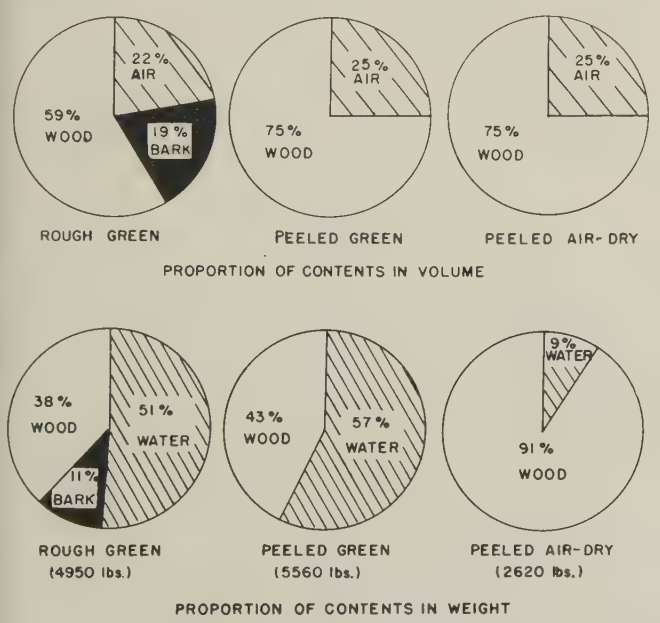

Fig. 3. Proportion of weight and volume of a 128-cu. ft. cord in wood, bark, water, and airspace—Black Hills ponderosa pine, 51 to 100 yr. old

Actual wood volume for peeled cords and rough cords was not greatly different from plot to plot. The average volume for a rough cord was 75.9 cu. ft. and ranged from 72.9 to 78.5 cu. ft. while the average for a peeled cord was 96.1 cu. ft. and ranged from 95.8 to 96.5 cu. ft. However, wood weights (lb. per cu. ft.) for yellow-bark trees were generally greater than weights for wood from young trees. Therefore, yellow-bark trees would yield about 48 lb. more kraft fiber and 95 lb. more groundwood fiber per air-dry rough cord than the young trees.

The greater wood content of a peeled cord makes possible the shipment of about 20% more wood volume in the same space that would be occupied by a rough cord. Also, if the peeled 100-in. bolts from the younger stands were air-dried before shipment, the weight of a 25-cord carload could be decreased as much as 47%. The shipping weight of 25 cords (133 cu. ft.) would be about 128,700 lb. for rough green wood or 68,100 lb. for air-dry peeled wood. Hence, for a shipment of 25 cords of peeled dried wood a saving in shipping weight of as much as 60,600 lb. could be obtained plus a gain of 14,300 lb. of air-dry wood. This relationship would hold true for older stands although the values would change because of difference in weight per cubic foot.

Black Hills ponderosa pine wood requirements compare favorably with those for Lake States jack pine and lodgepole pine. For example, Keepers (*7*) found that Lake States jack pine has a wood content of 96.9 cu. ft. per peeled cord and a range in moisture-free weight of 20.8 to 24.9 lb. per cu. ft. Black Hills ponderosa pine has an average wood content of 96.1 cu. ft. per peeled cord and an average moisture-free weight per cubic foot of 24.8 lb. for stands 51 to 100 yr. old. If we assume a similar wood content and 24.8 lb. per cu. ft. for a peeled lodgepole pine cord, the wood requirements for pulp would be about the same for the three species. However, rough wood requirements favor jack and lodgepole pine because Black Hills ponderosa pine has thicker bark. Average bark content is 17% for Lake States jack pine (*8*) and 6% for lodgepole pine. Hence, about 1.8 rough cords of jack pine and 1.7 rough cords of lodgepole pine per ton of air-dry sulphate pulp would be required as compared with 2.0 rough cords of Black Hills ponderosa pine.

SUMMARY

Pulpwood characteristics were determined from trees cut on 39 plots located throughout the Black Hills and Bear Lodge Mountain area of South Dakota and Wyoming. These trees, marked according to the prevailing procedure, ranged from 6.0 to 12.9 in. d.b.h., and from 19 to 77 ft. high. Trees were felled and cut

into 100-in. bolts to 3.5 in. d.i.b. Bolts from each plot were measured at each end and stacked to get cord equivalents (128 cu. ft.). Bolts from 13 plots were peeled and restacked to get a direct comparison of cord equivalents for both rough and peeled wood.

A stacked cord of rough bolts from stands 50 to 100 yr. old contain on the average, 59% wood (75.9 cu. ft.), 19% bark, and 22% airspace. In contrast, a cord of peeled wood from these stands contains 75% wood (96.1 cu. ft.), and 25% airspace. A rough green cord weighs 4950 lb. (includes 560 lb. of bark) and a peeled green cord weighs 5560 lb. A considerable drop in weight of the peeled cord takes place when the peeled wood is allowed to air-dry. An air-dry peeled cord weighs 2620 lb. and contains about 550 lb. more wood than a rough cord.

Wood content for Black Hills ponderosa pine (young stands) is about 20% less or peeled wood than for unpeeled wood. A sulphate pulp with 48% yield would require 2.0 cords of unpeeled wood per ton of air-dry pulp compared with 1.6 cords of peeled wood. Groundwood pulp with a 95% yield would require 1.0 rough cord per ton air-dry pulp and 0.8 cord of peeled wood per ton. These wood requirements for peeled wood are essentially the same as those of Lake States jack pine and lodgepole pine.

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Surface Chemical Studies on Pitch

II. The Mechanism of the Loss of Absorbency and Development of Self-Sizing in Papers Made from Wood Pulps

JOHN W. SWANSON and SHIRLEY CORDINGLY

One of the more disconcerting problems encountered in the manufacture of absorbent products from wood pulps is the gradual loss of absorbency and development of sizing toward aqueous fluids. The subject is treated as a basic problem of surface chemistry involving several constituents of the pitchy materials present in wood pulps. The pertinent literature is reviewed and a theory involving migration of the resinous materials and overturning and anchorage of the amphipathic (polar-nonpolar) molecules upon the fiber surface is suggested. Experimental data which tend to support the proposed mechanism are presented.

One of the more disconcerting problems encountered in the manufacture of absorbent wood pulp products is the gradual loss of absorbency as the product ages. Facial tissue, towels, sanitary napkins, hospital wadding, surgical bandages, and many similar types of products may possess satisfactory absorbency immediately after manufacture. But, after aging in a warehouse or on a storekeeper's shelf for a period of weeks or months or sometimes after autoclave sterilization, the product becomes much less absorbent and in some cases highly resistant to the penetration of aqueous fluids. Some corrugated board manufacturers, particularly those employing certain semichemical processes also encounter a similar problem referred to as air-sizing or self-sizing. The initially unsized medium gradually becomes quite water resistant and poor adhesion results during the corrugating operation if the board has been stored too long before use.

These phenomena present an interesting problem in surface chemistry. Apparently the paper or board as a whole does not change in chemical composition or physical structure to any discernible extent. However, the surface properties change considerably as indicated by the loss of absorbency and development of sizing. This paper is concerned with a review of some of the theory which may be pertinent to the problem, and data are presented from several model experiments which suggest a mechanism of the loss of absorbency and development of self-sizing.

THEORETICAL CONSIDERATIONS

Absorbency is a property concerned with the rate of penetration of liquids into irregularly shaped capillary structures. Internal sizing of paper depends upon similar principles. It is clearly established that all penetration phenomena depend ultimately upon the Van der Waals forces of attraction between the molecules of the solid and liquid. These attractive forces cause the surface of a liquid within small capillaries to become curved and because of the higher free energy in the surface region, a pressure difference develops across the meniscus (*1*). This pressure difference causes the liquid to spontaneously penetrate or resist penetration depending upon the relative magnitudes of the attractive forces. This is expressed by the fundamental equation of capillarity for a spherical element of liquid surface:

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$$(P_1 - P_2) = \Delta P = \frac{2\gamma \cos \theta}{r} \qquad (1)$$

where P_1 and P_2 are the pressures on the concave and convex sides of the meniscus, respectively, ΔP is the pressure difference across the meniscus, γ is the specific free surface energy of the liquid (equivalent mathematically to the surface tension), r is the radius of the capillary tube, and θ is the contact angle between the liquid and the solid. When the contact angle is acute, the pressure difference is positive and the liquid spontaneously penetrates into the capillary because of this pressure. As the angle becomes larger and the cosine smaller the pressure difference becomes smaller. When the contact angle is obtuse, cos. θ is negative and the pressure difference resists penetration of the liquid into the capillary. Under this condition it is necessary to impose a hydrostatic head on the system in order for liquid penetration to occur. Equation (1) implies that best absorbency should occur when the contact angle is zero. However, it says nothing about the rate of absorption of liquid.

Equation (1) may be combined with Poiseuille's equation for volume rate of flow through a capillary.

$$V = \frac{\Delta P r^4 t \pi}{8 \eta l} \qquad (2)$$

to obtain equation (3) expressing the depth of l^2 = penetration of liquid in a given time.

$$l^2 = \frac{\gamma r t \cos \theta}{2\eta} \qquad (3)$$

where l is the distance penetrated in time t and η is the coefficient of viscosity of the liquid. Equation (3) may be differentiated with respect to time to obtain the corresponding rate of penetration (4).

$$\frac{dl}{dt} = \frac{\gamma r \cos \theta}{4 \eta l} \qquad (4)$$

This is often referred to as the Washburn equation (*2*). It is valid only when the contact angle is acute, when laminar flow exists and when air resistance and gravitational effects may be excluded or neglected. It tells us that the rate of penetration of a liquid in any uniform capillary under its own capillary pressure is directly proportional to the surface tension of the liquid, to the radius of the capillary, and to the cosine of the contact angle, and the rate is inversely proportional to the viscosity of the liquid and to the length of capillary already filled by the liquid.

These equations apply strictly only to a single, uniform, cylindrical capillary. The porous structure of paper and board is much more complex. Here, the pores are not uniform cylinders and the variations in their size and the numerous bifurcations, constrictions, and interconnections further complicate penetration in such systems. On the other hand, Peek and McLean (*3*) have indicated that the rate of penetration into a complicated network of capillaries requires no more complex dependence on γ, l, and η than does a simple capillary. A thorough discussion of penetration phenomena in a more complex system has been presented by the staff of The Institute of Paper Chemistry (*4*).

The Contact Angle

Even though the structure of paper may be complicated it is clear that the contact angle determines whether or not spontaneous penetration occurs in a finite time. Now let us examine more closely the factors which determine the contact angle. The magnitude of the contact angle between a liquid and a plane solid surface depends upon the relative Van der Waals forces of attraction between the liquid molecules themselves and between the molecules of liquid and solid. These forces determine the wettability of the solid surface. In terms of their corresponding interfacial free energies the relationship may be expressed by Young's equation (*5*),

$$\cos \theta_A = \frac{(\gamma_S - \gamma_{SL})}{\gamma_L} \qquad (5)$$

where $\cos \theta_A$ is the cosine of the *real advancing contact angle* θ_A, on a smooth surface, and γ_S, γ_{SL}, and γ_L are the specific free surface energies of the solid-vapor, solid-liquid, and liquid-vapor interfaces, respectively. Wenzel (*5*) has shown that where the solid surface is not plane but is rough, the right-hand side of equation (5) should be multiplied by R_1, the roughness factor, defined as follows:

$$R_1 = \frac{\text{actual surface area}}{\text{geometric surface area}} \qquad (6)$$

This modified contact angle is called the apparent *advancing contact angle* and now takes the place of the real angle in previous expressions. When the solid is *both* rough and porous or when the real contact angle on a rough surface is greater than 90° the *apparent advancing contact angle* θ_{AA}, is related to the *real advancing contact angle* θ_A by equation (7) as shown by Cassie and Baxter (*6*).

$$\cos \theta_{AA} = R_1 \cos \theta_A - R_2 \qquad (7)$$

where R_1 is the total area of solid-liquid interface and R_2 is the total area of liquid-vapor interface in a plane geometrical area of unity parallel to the rough surface; these are the roughness and porosity factors, respectively. Combining (7) and (5) gives (8).

$$\cos \theta_{AA} = R_1 \frac{(\gamma_S - \gamma_{SL})}{\gamma_L} - R_2 \qquad (8)$$

Let us now examine the changes which may occur as absorbency decreases and sizing develops. Immediately after the paper product has been manufactured, the surface energies are such that the value of $\cos \theta_{AA}$ is positive because penetration occurs rapidly and spontaneously. The changes which occur during aging must, therefore, involve changes in one or more of the quantities of equation (8) to a relationship less favorable to penetration. All of the factors in equation (8) can change the value of the apparent advancing contact angle, acting singly or together. The roughness factor simply magnifies the wetting *or* nonwetting properties of the surface depending upon the relative magnitudes of γ_S and γ_{SL}. Therefore, roughness cannot change the sign of $\cos \theta_{AA}$. On the other hand, Cassie and Baxter (*6*) have shown that changes in the porosity factor can change the sign of $\cos \theta_{AA}$ when the geometry of the fibrous structure is suitably altered. However, it seems reasonable to assume that neither the roughness nor the porosity changes appreciably

during aging of the paper and we shall not consider these effects further at this time.

If, during an absorbency or size test, small amounts of contamination spread from the paper onto the aqueous surface, γ_L will decrease slightly under low surface pressures. This would increase the positive value of cos θ and increase the rate of penetration. Wetting agents in the water would have a similar effect. Thus, although small changes in γ_L may occur during testing of an aged paper it is obvious that such change would improve penetration, not decrease it. Furthermore, the change in γ_L could not alter the sign of cos θ_{AA} from positive to negative and develop water resistance. Therefore, from a fundamental standpoint it becomes evident that self-sizing or loss of absorbency involves changes in the relative values of γ_S and γ_{SL}. The paper or board surface has a high average free surface energy before aging and this must gradually decrease to a lower average free surface energy after aging.

The value of the interfacial free energy γ_{SL} lies somewhere between zero and the higher of the two surface energies involved in formation of the interface. It follows that when the surface of the paper has aged, γ_S has decreased and eventually must be less than γ_L, the free surface energy of water, where water resistance develops. Stated in other words the attractive forces of the first layer of molecules of the fiber surfaces have changed from a relatively high value before aging to a relatively low value after aging. Each type of molecular grouping has a characteristic molecular force of attraction on other molecules. Therefore, any mechanism of self-sizing or loss of absorbency must explain the change in terms of the chemical composition of the surface.

Generally speaking, polar solids have high free surface energies and nonpolar hydrocarbons have low surface energies. Thus, the change in contact angle and the associated attractive forces might be explained if the first layer of molecules on the fiber surfaces becomes less polar and more hydrocarbonlike in chemical composition. This change could result if (1) the fiber surfaces became partially covered during the aging process with one or more layers of certain constituents in the extractives fraction of the pulp or, (2) if the aging process chemically alters any of the fiber constituents on the surface to a more hydrocarbonlike structure.

PRELIMINARY EXPERIMENTS

In order to decide between the two suggested possibilities for decreasing γ_S, several preliminary experiments were performed with an unbleached, medium cooked 100% spruce sulphite pulp and a 100% aspen semichemical pulp. Handsheets (60 lb., 25 × 40—500) were prepared from moderately beaten samples of the pulps before and after extraction with benzene-alcohol (2:1). These handsheets were tested for their tendency to become sized under natural and artificial conditions of aging. The fluorescence size test (*7*) was used for determination of sizing. The tests are summarized in Table I.

The handsheets prepared from the unextracted pulps were essentially unsized when tested within a few days after preparation. However, after aging at room temperature (20–25°C.) for 69 days, both pulps developed appreciable sizing. Artificial aging for six hours at 105°C. produced hard-sized papers and the degree of sizing increased further upon heating for 24 hr. The handsheets prepared from the corresponding benzene-alcohol extracted pulps did not develop sizing either upon natural aging or upon being artificially aged at 105°C. for as long as 3 days. Thus, it does not seem likely that aging of the cellulose surface in the absence of extractives is responsible for the decrease in free surface energy of the solid surface.

Table I. The Effect of Natural and Artificial Aging Upon the Sizing of Spruce Sulphite and Aspen Semichemical Pulps

	Conditions of treatment			*Fluorescence size test, sec.*
		Aging of sheets		
Type of pulp	*Extraction of pulp*	*Temp., °C.*	*Time*	
Spruce sulphite[a]	None	25	4 days	1
	None	25	69 days	18
	None	105	6 hours	98
	Benzene-alcohol	25	4 days	0
	Benzene-alcohol	25	68 days	0
	Benzene-alcohol	105	3 days	0
Aspen semichemical[a]	None	25	14 days	7
	None	25	69 days	14
	None	105	6 hours	70
	None	105	24 hours	93
	Benzene-alcohol	25	7 days	0
	Benzene-alcohol	25	68 days	0
	Benzene-alcohol	105	48 hours	1
	Benzene-alcohol	105	3 days	0

[a] The benzene-alcohol (2:1) extractives content of the spruce sulphite pulp was approximately 1% and of the aspen pulp 2%.

Apparently the benzene-alcohol extraction removed material from the pulp which permits sizing to develop —at least at higher temperatures. The other suggestion made above, that sizing develops because of the redistribution of the organic solvent extractables on the fiber surface was considered next.

Probably a major part of the extractives present in an unaged sheet of paper made from wood pulp exists in the ray cells or resin ducts. Such cells are present in a minor quantity as compared with the total quantity of fiber present. Back (*8*) and several others (*9–10*) have reported decreased pitch troubles and improved absorbency by screening out about 2% of the fines and it has long been known that alkaline extracted or higher purity pulps possess superior absorbency. In this condition the majority of fiber surfaces are readily wetted by water, a high *average* free surface energy of the solid exists, a low contact angle results, and low sizing and good absorbency are obtained.

There seem to be at least two possible mechanisms whereby the extractives could become redistributed. First, those constituents which possess positive spreading coefficients (*11*) might spread as monolayer films over the solid surfaces or upon the film of water existing upon the fiber. Such a film may then become anchored to the solid in a subsequent reaction. Secondly, certain constituents may undergo vapor-phase transport from ray cells or resinous particles to neighboring fiber surfaces. Here they may become adsorbed until the average free surface energy is lowered and produces slower penetration, loss of absorbency, and finally sizing.

Preliminary experiments in which small droplets or particles of whole resinous extracts were placed upon paper indicated that monolayer spreading does not occur to an appreciable extent during one year.

The investigation seemed to narrow down to the possibility of vapor-phase transport.

To test this hypothesis in a preliminary way, handsheets made from benzene-alcohol extracted pulp were suspended over some of the extract which had been evaporated to dryness. This suspension was done first by placing a 10-cm. strip of paper vertically in a test tube which contained a small quantity of extractives in the bottom, close but out of contact with the paper. This is shown in A of Fig. 1. The tube was then heated at 105°C. for 16 hr., and sizing was estimated qualitatively by determination of the apparent advancing contact angle of water on the strip of paper at various positions. The region of paper within 1 cm. from the bottom end of the tube had a contact angle greater than 90°. No penetration of liquid water occurred during 90 sec. However, at progressively greater distances from the end, the initial contact angle became smaller and at 8 cm. instantaneous penetration occurred. This experiment strongly indicates that certain constituents in the extractives are sufficiently volatile at 105°C. to vaporize and become adsorbed upon the fiber surface to produce sizing.

However, when samples of paper were stored over the pitch in stoppered test tubes as shown in B of Fig. 1, it was found necessary to heat the system for 5 days at 105°C. to develop a size value of 80 sec. Furthermore, when this system is maintained at room temperature only very little sizing develops over a period of 2 months. It was decided therefore that an investigation should be made of some of the important variables.

The transfer of liquid or solid extractives through the vapor phase to paper structures has been investigated with a model substance, stearic acid, and handsheets prepared in the presence of deionized water, water containing 200 p.p.m. of hardness (as calcium chloride) and with water containing 4% of alum based on the pulp. Stearic acid was chosen for study because it is representative of the saturated fatty acids in the extractives, and because it could be obtained in pure crystalline form tagged with radioactive carbon-14. The present study is not complete but the results are believed to be of sufficient interest to report at this time.

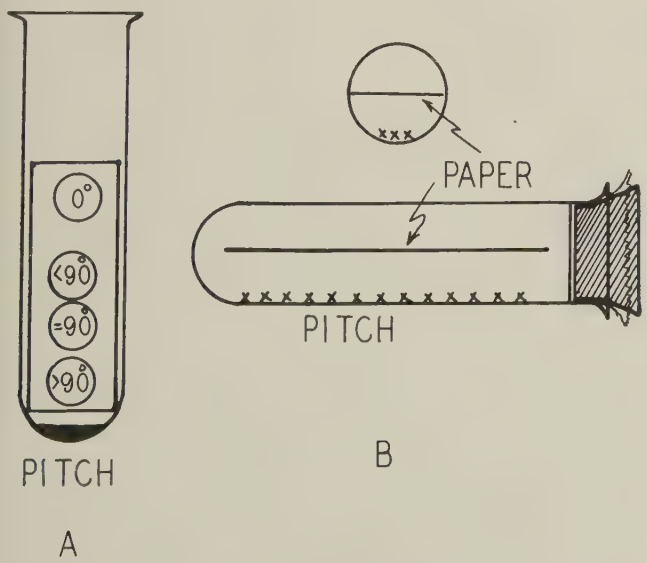

Fig. 1. Arrangement of paper specimen in vapors contained in test tubes

Beating the Pulps and Preparation of Handsheets

Large quantities of the spruce sulphite and aspen semichemical pulps were extracted for 3 days with benzene-alcohol (2:1) and were then air dried at room temperature. The extracted pulps were soaked in deionized water for several hours, and then slushed for 10 min., and beaten in a Valley beater at a consistency of 1.5%. The spruce sulphite was beaten to a S.-R. freeness of 580 ml. and the aspen pulp to 650 ml.

Aliquots of each pulp were made into handsheets having a basis weight of 60 lb. (25 × 40—500). Deionized water was employed in the entire procedure but sets of handsheets were prepared under three different ionic conditions. One set was made with deionized water containing sufficient hydrochloric acid to bring the pH to 5. This was done to eliminate most of the ash from the pulp. A second set was made in which all water contained 200 p.p.m. of calcium ion (as calcium chloride). The pH in the sheet mold was 5.8. A third set of handsheets was made in which 4% of alum based on the pulp was added to the water. The pH in the sheet mold in this instance was 4.5. All sheets were pressed between blotters at 50 lb. per sq. in. for 5 min. and dried on blotters for 7 min. on a drum heated with 3.5 lb. steam pressure.

THE EFFECT OF EXPOSURE TO STEARIC ACID VAPOR UPON THE SIZING OF HANDSHEETS

Preparation of Tubes Containing Radioactive Stearic Acid

A stock solution of C^{14} tagged stearic acid was prepared from 14.27 mg. of radioactive stearic acid and 235.84 mg. of reagent-grade nonradioactive stearic acid dissolved in 25 ml. of purified benzene. Stock solution, 12.5 ml. was then diluted with benzene to the mark in a 25-ml. volumetric flask containing 124.95 mg. of nonradioactive stearic acid. One milliliter of this solution containing 10 mg. or 1 microcurie of radioactive stearic acid (approximately 2.3% solid stearic acid based on the paper sample) was added to a nearly horizontal 38 × 200-mm. test tube and the benzene was allowed to evaporate at room temperature. The evaporation was done in such a way that the crystalline stearic acid was distributed uniformly along a line from the back to about 25 mm. from the front of the tube as shown in B of Fig. 1. Each tube was placed in a rack which fixed its horizontal position and prevented rolling. The tubes were then heated at 105°C. for 0.5 hr. to remove residual benzene and to fuse the stearic acid to the glass. The tubes were then closed with cellophane-covered rubber stoppers and transferred to an oven of the desired temperature for 0.5 hr.

Exposure of Paper Samples to Stearic Acid Vapor

Specimens of each set of handsheets, $6^3/_4$ by $1^3/_4$ in. were placed diametrically in test tubes containing stearic acid as indicated in B of Fig. 1. The cellophane-covered stopper was replaced and fixed in position by means of rubber bands. It was later found desirable to carefully invert the tubes so that the fused stearic acid was held above the paper specimen. This gave greater uniformity of stearic acid vapor within the tube but apparently did not alter the quantity of stearic

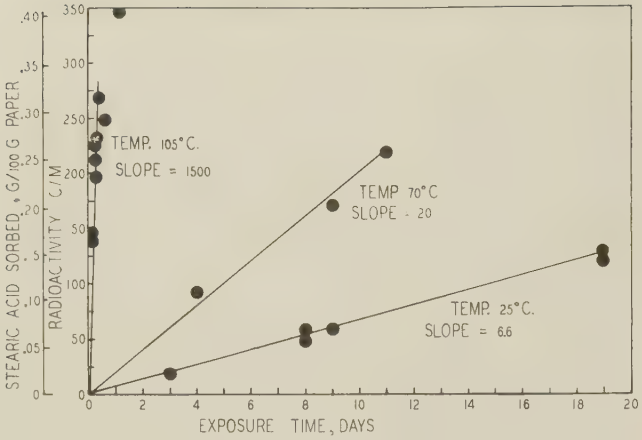

Fig. 2. Effect of exposure time and temperature upon adsorption of stearic acid vapor by spruce sulphite handsheets

acid adsorbed by the papers. Paper specimens were maintained at temperatures of 25, 50, 70, and 105°C. Suitable controls were also heated in the absence of stearic acid vapor.

At desired intervals, samples were removed from their tubes and immediately placed in empty test tubes at room temperature. The radioactivity was then determined at several positions on both sides of the specimen by means of a thin window Geiger tube and a Model 2000 decimal scalar manufactured by the Berkeley Scientific Corp.

It was found important, particularly at the higher temperatures, to prevent "raining" of stearic acid upon the samples during removal from the oven. This was largely prevented by quickly removing the specimen from the tube before it was taken from the oven. Where "raining" occurred, the determination of stearic acid by radioactive counting was in error. Presumably, this error was caused by superficial condensation of stearic acid whose beta radiation was therefore absorbed by the cellulose to a lesser degree than if the same quantity of acid were distributed more uniformly throughout the sheet structure.

Sizing was determined in several positions on each specimen by means of the fluorescence size test (*7*) as recently modified at The Institute of Paper Chemistry.

The Effect of Temperature on the Sorption of Stearic Acid Vapor

The relationship between sorbed stearic acid and time of exposure of the paper to the vapor at 25, 70, and 105°C. is shown in Fig. 2. The curves are shown as linear but it is not to be expected that this relationship should be linear over more than the early part of the sorption where the surface of the fiber is incompletely covered with stearic acid. Therefore, the slopes of the curves illustrate only the relative *initial* rates of sorption and not the over-all rate. The curve at 105°C. is drawn only through the points obtained during the first 4 hr. At longer times the rate slows down considerably at this temperature.

It is evident from the slopes of the curves that the temperature has a profound effect upon the rate of stearic acid. The initial rate at 105°C. is 75 times as fast as the rate at 70°C. and 227 times as fast as the rate at 25°C. under the particular conditions employed. Indeed, if the rate at 25°C. slows down as greater

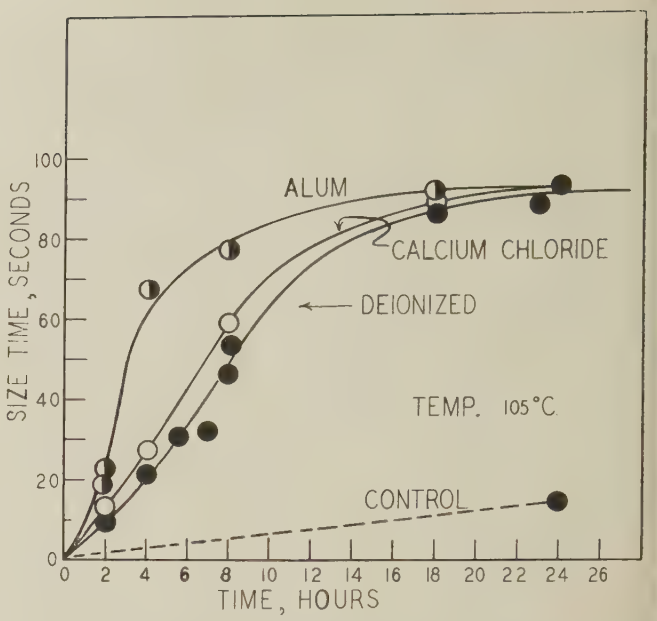

Fig. 3. Effect of exposure to stearic acid vapor on sizing of spruce sulphite handsheets

coverage of the fiber surface is obtained, a high degree of sizing may never be obtained at room temperature under these conditions.

These experiments show conclusively, however, that stearic acid volatilizes even at room temperature from the crystalline state and becomes adsorbed on cellulose surfaces an appreciable distance away.

The Development of Sizing Upon Exposure to Stearic Acid Vapor

The effect upon the fluorescence size value of exposing spruce sulphite handsheets to stearic acid vapor at 105°C. is illustrated in Fig. 3. We learned here unfortunately that benzene-alcohol extraction of the large batches of pulp had not removed quite all of the extractives of interest. This is shown by the development of some sizing of the control under extreme conditions. This does not affect the conclusions of the present experiments. It is evident

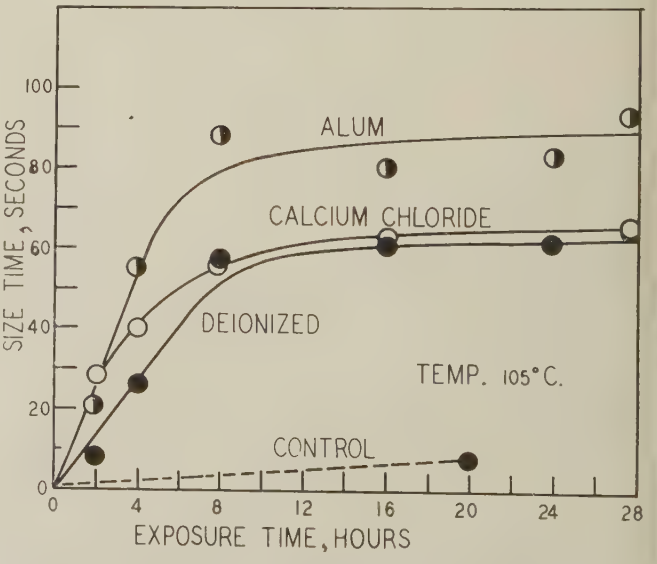

Fig. 4. Effect of exposure to stearic acid vapor on sizing of aspen semichemical handsheets

that sizing with stearic acid vapor develops rather rapidly over the first few hours and then levels off. Also, it is noted that there is a pronounced difference in the rate of size development depending upon the ionic condition under which the papers were made. The sheet containing calcium ion apparently developed sizing a little more rapidly than the sheet made in slightly acidic deionized water. The presence of aluminum had a much greater effect. The alum sheet developed a size value of 70 sec. in 4.5 hr. whereas about 10.5 hr. were required to develop equivalent sizing in the deionized sheet. Similar data are presented for the aspen pulp in Fig. 4. The alum sheet for the aspen pulp reached a significantly higher plateau of sizing than the deionized aspen sheet whereas both types of papers for the sulphite pulp ultimately reached the same level.

During the early period of adsorption of stearic acid vapor, the sheets that contain aluminum do not absorb a significantly greater quantity of stearic acid. Apparently the adsorbate is utilized more efficiently in the presence of aluminum ion. For example, the deionized aspen sample at 4 hr. exposure has a stearic acid content of 0.26 g. per 100 g. of paper and the corresponding sample containing aluminum ion contained 0.27 g. per 100 g. of paper, but the aluminum sample shows a size time of 55 sec. as compared with only 26 sec. for the deionized sample. However, when the respective plateaus are reached in the two cases, the aluminum-treated paper adsorbs more stearic acid. This is to be expected because in the early stages of the adsorption most of the stearic acid molecules which strike the surface are probably adsorbed. Later on when the surface approaches saturation the aluminum sample adsorbs more stearic acid because of the formation of the much less volatile and more strongly bound aluminum stearate. Rideal and Tadayon (*12*) showed that the presence in a solid surface of small amounts of ions which could react to form a salt with a monolayer acid caused that surface to be favored with regard to the transfer and adsorption of the acid from a less highly favored location.

The more rapid development of sizing when aluminum is present in the sheet is believed to result from anchoring and better orientation of the fatty acid molecules as discussed by Langmuir (*13*), Young (*14*), and Rideal and Tadayon (*12*). Langmuir (*13*) showed that although the first layer of molecules is the same on various solids, the contact angle differs very much depending upon the strength of anchorage of the carboxyl group of the fatty acid to the solid surface. Probably the attraction between the carboxyl group and the cellulose surface is sufficiently great to orient the molecule in a position with the hydrocarbon radical farthest away from the solid surface, but a drop of water also possesses attraction for the carboxyl groups and competes with the solid surface for such groups. During a size test the contact angle between water and the layer of fatty acid on the solid surface depends upon the strength of anchorage of the polar group to the solid and the proportion of amphipathic (polar-nonpolar) molecules which can be overturned and brought into contact with the water surface during a short interval of time.

It is interesting to note that exposure of paper to the vapors of methyl esters of fatty acids at 105°C. did not produce sizing even after many hours. Presumably the reason for this is that the methyl esters cannot become anchored to the fiber surface. This strongly indicates the importance of anchorage of the carboxyl groups to prevent overturning of the molecule during the size test.

It is apparent from the general shapes of the curves in Figs. 3 and 4 that there are two regions of sizing development. This fact is emphasized for the aspen pulp by plotting the data on a log-log basis in Fig. 5. Some of the data for the 70°C. experiments are also included in this figure. The data taken at 50°C. have not been plotted because sizing developed much more slowly and the data were more erratic. Quite possibly this occurs because of nonuniformity of the vapor within the tube and the comparatively large distance for mass transfer. The very similar initial inclinations of the lines in Fig. 5 indicate that the mechanism of the adsorption of stearic acid is similar in the presence and absence of alum and at the different temperatures. The rate of adsorption and development of sizing are simply much slower at 50 and 70°C. than at 105°C. At room temperature the stearic acid content levelled off at a radioactivity of slightly over 100 counts per min. This corresponds to a stearic acid content of about 0.14 g. per 100 g. of paper which is apparently insufficient to develop appreciable sizing in the papers under these conditions.

The amount of stearic acid needed to reach a sizing value of about 60 sec. where the log-log plot changes slope is approximately 0.3 g. per 100 g. of paper. In an oriented condition the stearic acid molecule occupies a cross-sectional area of 21 sq. A per mol. and 0.3 g. will then occupy about 150 sq. m. or 1.5 sq. m. per g. of paper. This value is of the order of magnitude of the surface area of the pulp fibers in the sheet. It appears therefore that the change in slope may be related to the point at which the fibers are completely covered with a monolayer of stearic acid.

The Temperature in a Roll of Paper During Storage

Probably the temperature in a jumbo roll does not attain 105°C. and if it did momentarily, it would not remain this high for a very long time. Thus, the use

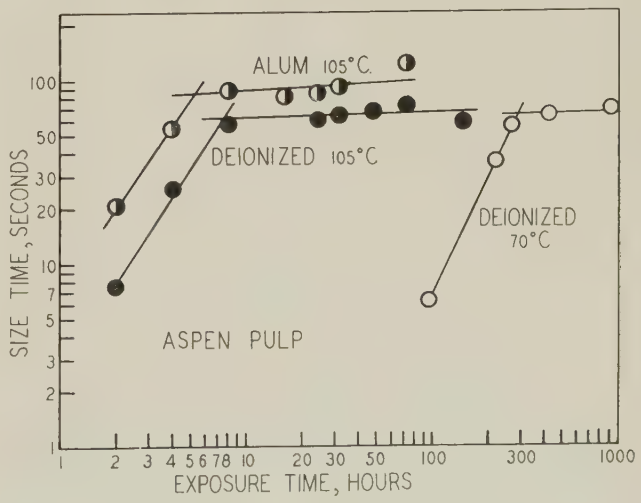

Fig. 5. Effect of exposure to stearic acid vapor on sizing of aspen semichemical handsheets—log-log plot

of high temperatures for these studies may be justifiably questioned. We wish to point out that this study has been done primarily to prove the hypothesis that materials such as the fatty acids can undergo vapor-phase transport from one point to another some distance away and there become adsorbed and produce hard sizing. The higher temperature was employed so that the studies could be made in a reasonable length of time. The behavior of the controls which had been fully extracted with benzene-alcohol indicates that higher temperature probably only speeds the transfer and anchorage of the fatty acid. It is well known, however, that paper is a good insulating medium and the temperature in a large roll does remain at a reasonably high temperature for some time. No actual temperature data could be found in the literature but calculations made on the basis of cooling theory (*15*) indicate the following: If a 4-ft. diam. roll of paper has a temperature of 200°F. (93°C.) at the time it is wound and if the ambient temperature is 70°F. (21°C.) 1 hr. from the time it is rolled up, the temperature 1 in. from the surface will be 174°F. (79°C.) and 30 days later, 1 ft. from the surface the temperature will still be 84°F. (29°C.) or 14° above room temperature. Thus, somewhat elevated temperatures are to be expected in a roll for a considerable period of time and the higher the temperature the better will be the opportunity for vaporization and redistribution of fatty acid materials in the sheet. The vapor pressure of stearic acid is, of course, very low. But, even at room temperature there is a finite and appreciable vapor pressure because radioactive stearic acid transferred from the solid to the sheet at 25°C. through a distance of $^3/_4$-in. in the test tubes. No exact data for the vapor pressure of stearic acid at temperatures of present interest (25 to 105°C.) could be found. Values at much higher temperatures have been determined for distillation and purification of fatty acids. It is reported that stearic acid has a vapor pressure of 0.25 mm. at 158 to 160°C. (*16*). Young (*14*) mentions the vapor pressure of stearic acid as approximately 0.02 mm. of Hg at 91°C. Calculations employing the thermodynamic equation of Lederer (*17*) give vapor pressures of 5.5×10^{-3} mm. at 105°C. and 5.1×10^{-7} mm. at 25°C.

It should be pointed out that other fatty acids of somewhat lower molecular weight occur in the extractives in larger quantities than stearic acid. Among these may be mentioned oleic, linoleic, linolenic, and palmitic. At least oleic and palmitic in this series have a somewhat higher vapor pressure than stearic. Experiments have shown that exposure of handsheets to oleic acid vapor will develop sizing but at a somewhat slower rate than stearic acid. Also, exposure of the paper to the vapors of the resin acids and unsaponifiable fractions of the pitch will develop sizing. These experiments will be reported in a later paper.

The Effect of Transfer Distance

Perhaps the distance of transfer from the solid or liquid fatty acid to the cellulose surface is as important as the temperature and vapor pressure. It is well known in molecular distillation of low vapor pressure substances that proximity of the condenser is necessary in order for distillation to occur at an appreciable rate. The importance of this factor was shown in the following experiment. A specimen sheet was impregnated as uniformly as possible with 0.5 ml. of stearic acid (about 5 mg. or 0.5 microcurie) in benzene. The sheet was then heated for one hour at 105°C. to permit the molten stearic acid to migrate into the finer capillaries of the sheet. The specimen of paper was then cooled and four similar *untreated* specimens were placed on each side and the combination was placed between 8 by 8-in. Monel metal plates in an oven at 70°C. After 18 hr. the sheets were removed and radioactivity and sizing values were determined. The data are plotted in Fig. 6 where it is apparent that sufficient transfer occurred in 18 hr. to produce 20 to 25 sec. sizing in specimens adjacent to the source of stearic acid and some sizing in the sheets beyond. In the test tube where stearic acid and paper were separated by a distance of approximately $^3/_4$-in. it required about 170 hr. to develop a similar degree of sizing.

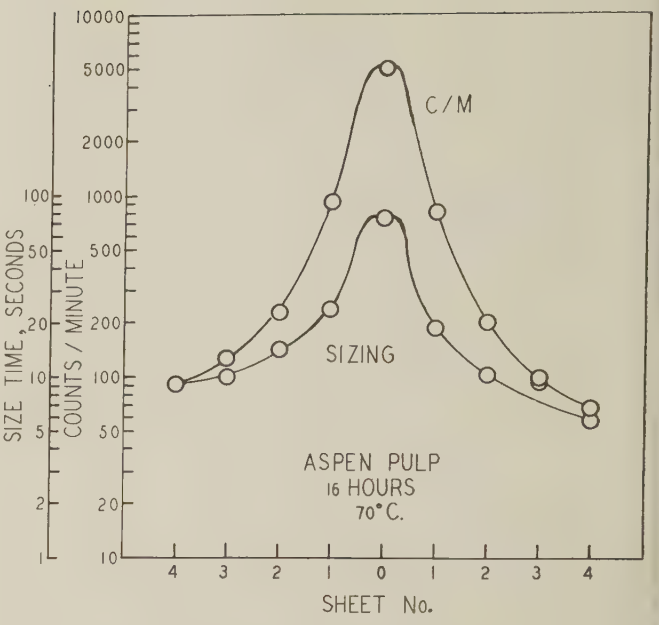

Fig. 6. The effect of proximity on the transfer of radioactive stearic acid from an impregnated sheet to non-impregnated handsheets at 70°C.

A duplicate experiment made at room temperature has also shown a much more rapid transfer of stearic acid, and sizing has developed after 44 days in sheets containing aluminum ion.

These experiments are being continued with a more refined technique employing atmospheres of accurately known partial pressures.

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Natural Variation in *Populus Tremuloides* Michx.

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Populus tremuloides **characteristically occurs in clones which originated as sprouts from a common root system. Natural variation between trees of this species may, therefore, be separated into variation within clones and variation between clones. The variation within a clone is environmentally caused. The variation between clones is caused by differences in environment as well as in genetic constitution. Diameter growth, volume growth, and specific gravity showed wide differences in one and the same clone as compared to between-clone differences, whereas fiber length showed less pronounced within-clone variation. Height growth, some properties related to tree form and some leaf characters (of value in recognizing a clone) showed a considerable degree of uniformity within clones. These results indicate that selection for form promises to be effective as a method of aspen improvement, whereas selection for fiber length, specific gravity, and growth rate may be considerably less so.**

Past studies of wood characteristics and pulping and papermaking properties of triploid and diploid quaking aspen (*1*, *2*) indicated that the variation existing within each of these genetic types was at least as important as the difference between them. It seemed, therefore, that a more extensive study of the variation within each group might be extremely useful. The present paper describes such a study, and is addressed to variation in diploid quaking aspen. It is restricted to a portion of the study pertaining to properties which could be measured on the standing tree or samples from it. Further plans call for a study of the pulp and papermaking properties of some of the trees described.

EXPERIMENTAL APPROACH

The study of variation in aspen is complicated by the fact that aspen commonly occurs in clones, originating as sprouts from a single root system. Clones arise, for instance, when a mixed conifer-aspen stand is clear-cut and the area comes back into aspen from the roots which remain alive. In such a case the variation encountered should be separated into two different categories: (1) variation between trees belonging to the same clone, and (2) variation from clone to clone. This distinction is of considerable importance because trees of the same clone have the same genotype and differences between them are therefore strictly environmentally caused,* whereas differences between clones are due to both heredity and environment. These considerations imply two experimental requirements: the trees should belong to recognizable clones; and the clones should grow in relatively uniform areas.

If the first requirement is satisfied, it is possible to obtain a quantitative estimate of the variation entirely due to environmental factors. If the second requirement is fulfilled the environmental differences between the clones studied may be sufficiently reduced to permit detection of major genetic differences. To assure uniformity and at the same time obtain an adequate number of clones, the experiment was subdivided and four smaller areas were used rather than a single large one.

MATERIALS AND METHODS

To locate the trees for this experiment a survey was made early last spring, in which 37 clones were selected, fulfilling, as far as possible, the requirements outlined above. The clones were identified as such by external characteristics, the most useful of which are sex, time of flushing, bark color, and bark patterns. The use of these criteria does not preclude the possibility of occasionally mistaking similar appearing stems, belonging to more than one clone, for a single clone, but the method appears reliable enough to be used successfully in this type of study. From these clones 20 were selected for further study. They are located in the following areas:

Area 1: The lower north slope of Rib Mountain near Wausau' Wis.
Area 2: West of old State Highway 17 near Eagle River, Wis.
Area 3: East of old State Highway 17 near Eagle River, Wis.
Area 4: Both sides of the Norwich Road *ca.* 15 miles south of Ontonagon, Mich.

About 100 miles intervene between the most widely separated of these areas (areas 1 and 4). From each area, five clones were incorporated in the investigation, each clone being represented by five trees.

The properties studied include soil properties and tree characteristics related to growth, morphology, and wood quality.

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* In addition to the more obvious and familiar environmental causes of variation, this includes small age differences and variation due to the position of the stems on the original root system at the time the clone originated as a group of sprouts.

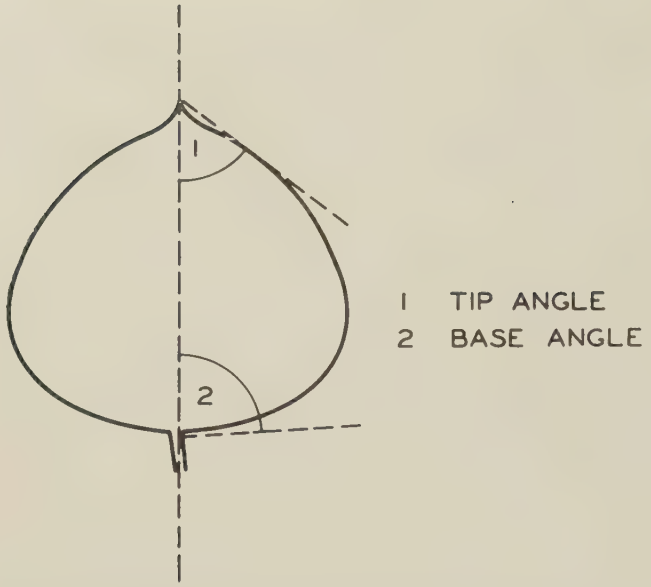

Fig. 1. Schematic representation of leaf angles measured

The soils of each of the study areas were examined in considerable detail. Three to five soil pits were dug at each of the four areas where clones were selected for further study. The soils were described and samples of the "A" and "B" horizons were taken for laboratory examinations. The soil texture (per cent sand, silt, and clay) was obtained as well as information on the acidity and levels of essential soil nutrients (N, P, K, Ca, and Mg). Calcium and magnesium are the exchangeable bases to which special reference is made in the results.

Tree growth was measured in terms of age, height, diameter at breast height, and form factor, and was expressed as the corresponding volume in cubic feet, based upon the form factor volume table of Mesavage (*3*).

Morphological properties such as straightness of stem, natural pruning, number of branches, and leaf form were measured quantitatively, or estimated where exact measurement was impossible. Properties pertaining to the form of the tree were included for their silvicultural importance, and leaf characteristics for their possible value as distinguishing features of particular clones. As wood properties important in pulping and papermaking, specific gravity and fiber length were evaluated.

The total height, height to a 3-in. top and height to the first live branch were measured in feet with an Abney level. Diameter at breast height was measured in inches with a diameter tape and the diameter at $16^1/_2$ ft. was determined in inches with a pole caliper. The crown diameter was measured from the ground as the average of two diameters, determined at right angles to each other. Bark thickness at breast height was measured to 0.05 in. with a Swedish bark gage. Examination of breast height increment cores provided the age determinations.

Sampling for leaf measurements was carried out by sawing two well-exposed branches out of the middle of the crown. From each branch six twigs were selected and from each of these the third and fourth leaves from the tip were measured. The measurements included the length and width of leaf blade, petiole length (all in millimeters), leaf tip angle and leaf base angle (see Fig. 1), and the number of serrations per centimeter.

The specific gravity of each tree was determined as grams of dry weight per cubic centimeter of green volume and obtained from four large (10 mm. diam.) increment borings taken at breast height.

Fiber length was determined from the same increment cores. The cores of each tree were divided into 5 yr. intervals, and the portions of equal age were composited. Each sample thus obtained was macerated with sodium chlorite and acetic acid according to the method of Spearin and Isenberg (*4*), stained with Congo Red and made into permanent slides. From each sample 80 fibers were measured. Finally the measurements were averaged, after first weighing the values in proportion to their relative contributions, increasing with distance from the pith, to the total amount of fiber present in the stem section, from which the cores were taken.

A number of these characters have been included in an analysis of variance, which makes it possible to estimate quantitatively how large a part of the variance encountered is due to differences between trees belonging to the same clone, how much is due to differences between the averages of clones growing in the same area, and how much can be attributed to the differences between the averages for each whole area.

An outline of the analysis of variance is shown in Table I. The variance associated with tree-to-tree differences within a clone is represented by σ^2, σ^2_C is the variance associated with differences between clones, independent of the variance within clones, and σ^2_A is the variance associated with differences between areas, independent of the variance associated with differences within one area. The estimates of these values are symbolically represented by S^2, S^2_C, and S^2_A, respectively.

Table I. Outline of Analysis of Variance

Source of variation	*Degrees of freedom*	*Sum of squares*	*Mean of squares*	*Mean of squares is an estimate of*
Total	99	..	..	
Areas	3	..	..	$\sigma^2 + 5\sigma^2_C + 25\sigma^2_A$
Clones within areas	16	..	..	$\sigma^2 + 5\sigma^2_C$
Trees within clones	80	..	..	σ^2

In addition to the analysis of variance a number of correlations were calculated relating specific gravity and fiber length to some of the most important growth features (see Table II). These were included to aid in evaluation of the specific gravity and fiber-length variation and to give an indication of how wood quality might be affected by selection for rapid growth.

RESULTS

Detailed field examination and laboratory investigations of the soils indicate that the areas selected were quite uniform with only area 4 showing any degree of within-area variability in the over-all soil profile appearance.

The area 1 soils were well-drained medium-textured soils with a very favorable water table. Area 2 soils were sandy with a water table at 6 to 8 ft. in depth. At area 3, soils were sandy with water-table levels be-

Table II. Correlations and Regressions Between Selected Variables

Dependent variable	Independent variable	Correlation coefficients: Average	Correlation coefficients: Between trees within clones	Regression coefficients: Average	Regression coefficients: Between trees within clones
Fiber length	Age	0.448[b]	0.152	0.0053[b]	0.0037
Fiber length	Total height	0.421[b]	0.070	0.0038[b]	0.0009
Fiber length	Diameter at breast height	0.403[b]	0.224[a]	0.0185[b]	0 0089[a]
Fiber length	Crown volume	0 133	0.214	0.0129	0.0157
Specific gravity	Age	0.354[b]	0.286[b]	0.0017[b]	0.0033[b]
Specific gravity	Total height	0.254[b]	0.287[b]	0.0009[b]	0.0016[b]
Specific gravity	Diameter at breast height	0.412[b]	0.362[b]	0.0075[b]	0.0068[b]
Specific gravity	Crown volume	0.197[a]	0.271[a]	0.0076[a]	0.0094[a]
Specific gravity	Tree volume	0.216[a]	0.165	0.0016[a]	0.0015

[a] Significant at the 5% level.
[b] Significant at the 1% level.

low 8 ft. during the dry part of the summer. Soils at area 4 varied in thickness of the sandy layer over heavy red clay from 0 to 7 ft. Water table levels also were quite variable in area 4. Based on soil properties, area 1 near Wausau, Wis., appeared to be the best site for tree growth of the areas studied and area 3 on the Rhinelander Paper Co. farm was the poorest.

Levels of nitrogen and phosphorus varied considerably in the soil profile ("A" horizon being much higher in both elements) but the average level between profiles within an area and the average level between areas varied but little. Soil texture (per cent sand, silt, and clay) and the level of exchangeable bases seemed to be the soil factors which contributed most to site differences. The depth of water table (often difficult to determine) also had an important influence on site quality. Because of the limited data involved, only trends in soil-site relationships were observed.

Table III presents some of the more significant soil data obtained from this study. The data listed are the weighted averages of the "A" plus "B" horizons.

Considering the gross features first, these data may be summarized by stating that the rate of growth was best in area 1, followed by areas 2 and 4 in close succession, while it was poorest in area 3. The differences in growth rate on these areas can be attributed primarily to differences in texture and amount of exchangeable bases. Depth of water table also appears to have an important influence on site quality. The most favorable sites were those with a relatively fine texture, a high level of exchangeable bases, and a water table at 3 to 5 ft. from the surface. These results are in general agreement with soil factors regarded important in the growth of aspen by research workers, as reviewed by Heinselman and Zasada (*5*).

Table III. Summary of Soil Properties[a]

Clone no.	Silt + clay, %	Acidity, pH	Available K, lb./A.	Exchangeable bases Ca, lb./A.	Exchangeable bases Mg, lb./A.	Site[b] index
1	71	4.8	100	920	185	82
2	67	5.0	100	800	285	82
3			(Same as clone 2)			81
5			(Same as clone 7)			90
7	64	5.1	105	1390	300	91
12	32	5.3	55	590	40	82
13	21	5.2	35	540	40	76
14	20	5.0	70	260	35	80
15	20	5.2	55	630	35	74
16	20	5.1	80	180	30	74
20	25	6.5	60	2040	60	85
21	29	5.2	55	670	60	70
22	17	5.0	75	1170	100	70
23			(Same as clone 22)			66
25	21	4.9	80	710	70	71
30	17	5.7	50	840	95	75
31	44	6.8	40	1760	275	76
33	62	4.5	110	710	85	75
34	73	5.9	190	4570	937	71
35	57	5.0	155	2200	321	71

[a] Soil data based on weighted average of levels in "A" and "B" horizons.
[b] Site index based upon height over age site index curves by Gevorkiantz, S. R., 1956. Site index curves for aspen in the Lake States. Lake States For. Expt. Tech. Note 464.

A closer examination of the variation pattern (see Table IV) reveals that the differences in average tree volume exhibited by the four areas contribute far more to the total variance than differences between clones. These contributions are represented, respectively, by S^2_A and S^2_C. This situation is most likely caused by the differences in age and site quality between the areas, which are a good deal larger than the differences in age and site between clones growing in the same area. The variation between trees belonging to the same clone, represented by S^2, is also quite large, but this must be due more to differences in crown class than to soil, since the soil conditions are evidently fairly uniform within a clone. This large amount of variation in volume growth of trees belonging to the same clone, as compared with interclonal differences in volume, makes it unlikely that selection for volume growth, as such, can be very effective.

Of the factors contributing to volume growth, the diameter at breast height follows the pattern of volume growth most closely, which is not surprising since the volume increases as rapidly as the square of the diameter. The form factor, however, varies rather little and does not contribute a great deal to the variation in volume. Height growth, a third factor influencing volume, contributed a sizeable amount to volume differences, but the pattern is distinct from the previous ones. The largest variation is again found between areas and is probably associated again with site quality and age, but here clonal differences contribute slightly more to the total variation than individual tree differences. Even though it is known that site differences influence height growth rather strongly, this gives some encouragement to tree selection on the basis of height.

Of the various properties associated with tree form only the branch angle could be expressed with sufficient accuracy to make a statistical analysis possible. The pattern is rather striking: The area differences contribute nothing to the total variation (S^2_A is actually negative) and clonal differences contribute substantially more variation than the differences between trees belonging to the same clone. This constitutes good evidence that the angle of branching is under rather strong genetic control. It should, however, be pointed out here that these data do not prove this; there always remains the possibility, which

Table IV. Analyses of Variance

Source of variation	df	Age		Total height		Height to first live branch		Diameter at breast height		Volume		Branch angle		Form factor		Crown volume	
		SS	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS	MS
Total	99	2825	...	4696	...	6511	...	185.04	...	1085.11	...	19,581	...	0.1573	...	41.3908	...
Areas	3	2142	714	2309	770	3384	1128	54.05	18.02	496.39	165.46	1653	551	0.0421	0.0140	8.4263	2.8087
Clones within areas	16	433	27	1365	85	1723	103	34.85	2.18	154.54	9.66	12,478	780	0.0473	0.0030	4.9212	0.3076
Trees within clones	80	250	3	1022	13	1404	18	96.14	1.20	434.18	5.43	5450	68	0.0679	0.0008	28.0433	0.3505
S^2_A	..	...	27	...	27	...	41	...	0.63	...	6.23	...	−9	...	0.0004	...	0.1000
S^2_C	..	...	5	...	14	...	18	...	0.20	...	0.85	...	142	..	0.0004	...	−0.0086
S^2	..	..	3	...	13	...	18	...	1.20	...	5.43	...	68	...	0.0008	...	0.3505

	df	Leaf length		Leaf width		Petiole length		Leaf base angle		Leaf tip angle		Leaf serrations, per cm.		Specific gravity		Fiber length	
		SS	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS	MS	SS	MS
Total	99	2828	...	4046	...	3155	...	37,881	...	2215	..	160.1	...	0.062187	...	0.3899	...
Areas	3	507	169	987	329	702	234	7003	2334	199	66	34.0	11.33	0.015200	0.0050667	0.1261	0.042033
Clones within areas	16	1060	66	1731	108	940	59	20,367	1273	921	58	63.2	3.95	0.013405	0.0008378	0.1118	0.006988
Trees within clones	80	1261	16	1328	17	1513	19	10,511	131	1095	14	62.9	0.79	0.033582	0.0004198	0.1520	0.001900
S^2_A	..	...	4	...	9	...	7	...	42	...	3	...	0.30	...	0.001692	...	0.001402
S^2_C	..	...	10	..	18	...	8	...	228	...	9	...	0.63	...	0.0000836	...	0.001018
S^2	..	..	16	..	17	..	19	...	131	...	14	...	0.79	...	0.0004198	...	0.001900

can be tested in a different type of study, that environmental differences between clones cause an important part of these differences in branch angle. However, in view of the negative value of S^2_A this seems unlikely. These data give, therefore, strong encouragement to the improvement of this aspect of tree form by means of selection.

Among the leaf characters measured, only the leaf width and the base angle (Fig. 1) showed variation patterns lending support to the view that those properties might be strongly inherited. Especially the base angle showed a very favorable pattern; the averages for the several areas varied only slightly and the clonal variation was more pronounced than differences between trees belonging to the same clone. In the future, this feature and the angle of branching will be added to the criteria for the demarcation of clones.*

Both specific gravity and fiber length showed a wide range of variation. Specific gravity ranged from 0.310 to 0.470 with an average value of 0.389 g. per cc. while fiber length varied between 0.77 and 1.06, averaging 0.91 mm.

The specific gravity shows a very high variation between trees belonging to the same clone, while clonal differences are only slight. The variation between the averages of the four areas is intermediate. This indicates that specific gravity is rather readily influenced by environmental factors, a view which is supported by the existence of significant correlations between specific gravity and both height and diameter growth (Table II). The fact that the correlations are positive shows that the specific gravity is to some extent increased by favorable growing conditions. Since the within-clone correlations are also significant, the crown class may be a contributing factor here. This might mean that specific gravity can be modified by silvicultural practice.

Fiber length varies a good deal from area to area and even more from tree to tree within a clone, whereas the variation between clones growing in the same area is somewhat less. The differences between the areas can be explained to a large extent by the existing age differences, since fiber length and age are closely related. The literature in support of this relationship has been reviewed recently by Spurr and Hyvärinen (*6*). The extent of the variation between clones appears to indicate that the genetic control of fiber length may be somewhat stronger than that of specific gravity.

DISCUSSION AND CONCLUSIONS

For the purpose of a projected follow-up study of differences in pulping and papermaking qualities, the trees involved in this study form a more than adequate source of material. There is a wide range of wood properties to choose from, which promises to be more than adequate to test how much pulp yield and quality are affected by specific gravity and fiber length as they can be measured on a standing tree.

From the viewpoint of its genetic implications these results may be analyzed following an approach similar to Toda's (*7*) adaptation for *Cryptomeria*,

* The possible utility of aspen leaf features and other morphological characteristics as indices useful in distinguishing clones of the forest is presently under intensive study by Burton V. Barnes at the University of Michigan.

Table V. Heritabilities and Expected Gains Through Selection

(Maximum values as estimated from the variation between clones and the variation within clones)

Property analyzed	*Maximum heritability*	*Average for all trees studied*	*Expected gain if best 5% selected, %*
Height	0.52	56.8 ft.	10
Height to first live branch	0.50	28.8 ft.	21
Diameter at breast height	0.14	7.6 in.	6
Volume	0.14	7.6 cu. ft.	9
Branch angle	0.68	61.3°	32
Form factor	0.33	0.76	3
Crown volume	−0.02	1 01 cu. ft./1000	..
Leaf length	0 38	56.6 mm.	7
Leaf width	0.51	56.6 mm.	11
Petiole length	0.29	45.6 mm.	7
Leaf base angle	0.64	83.5°	29
Leaf tip angle	0.39	52.2°	7
Leaf serrations/cm.	0.44	4.8 serrations/cm.	22
Specific gravity	0.17	0.389 g./cc.	2
Fiber length	0.35	0.906 mm.	4

of Lush's (*8*) work with animals. In this manner one may estimate an upper limit for the heritability of some of the properties studied. Heritability in its widest sense is the genotypic variance divided by the phenotypic variance. The genotypic variance is composed of three components: the additive genetic variance (σ^2_g), the variance associated with dominance effects (σ^2_d), and the variance associated with epistatic effects (σ^2_i). The phenotypic variance includes two additional factors: the variance associated with strictly environmental effects (σ^2_e) and the variance associated with interactions between genotype and environment (σ^2_j).

In the present study the S^2 calculated in the analysis of variance is strictly environmental and includes therefore only σ^2_e. S^2_C is an estimate of $\sigma^2_g + \sigma^2_d + \sigma^2_i + \sigma^2_{e2} + \sigma^2_j$, in which σ^2_{e2} is the variance associated with environmental differences between clones independent of within clone differences. If there is no greater environmental difference between clones than within clones, $\sigma^2_{e2} + \sigma^2_j$ will be zero and $S^2_C/(S^2+S^2_c)$ is an estimate of the heritability in its broad sense. This will seldom be the case and actual heritabilities are therefore expected to be lower than the values thus calculated. The heritability values for the properties studied, as calculated by this formula, are represented in Table V, column 2, and express numerically the description of the results given above. Also included in the table are average values for each property, and estimates of the per cent gain which might be achieved by selecting the best 5% of individuals. The latter values are computed as the product of the heritabilities and 2.064 times the standard deviation.

The tree properties which concern form appear to be most amenable to genetic improvement. The data support this view very well in the case of the angle of branching and even though it is not possible to give quantitative statements about stem straightness it does appear to follow a rather similar pattern.

Among leaf characteristics, especially the base angle was found to be highly uniform within a clone, and variable between clones, suggesting strong genetic control.

Growth rate, specific gravity, and fiber length, on the other hand, are more strongly influenced by the environment. There are indications (Table II) that good growth is associated with somewhat increased specific gravity and fiber length, and that crown class plays a role in this relationship. These findings add weight to arguments for more intensive silvicultural methods, such as proper thinning, and support further studies of silvicultural treatment in relation to wood quality improvement, including additional characteristics, such as per cent cellulose. The studies of Jayme (*9*) and associates of various hybrid poplars in Germany indicate that high cellulose is favored by rapid growth, decreased by suppression of the tree's crown, and achievable in marked degree by selection among the hybrids, while yield of pulp in rapidly growing trees decreases less with increasing height in the stem than is the case with slower growing trees.

Even though the data presented do not give numerically accurate estimates of heritabilities and amounts of gain to be expected from selection, some definite conclusions can be drawn from them, since the heritabilities are not expected to be higher than estimated by this method. Thus, although some gain would result, selection as a method for genetic improvement of wood quality and of growth rate does not promise to be very efficient, whereas selection for form has some good possibilities.

These results have significant implications for future aspen breeding work. Comparing the gain in fiber length expected from selection with the 26% difference in fiber length in favor of triploids which the present authors (*1*) found between triploid and diploid aspen, the polyploid methods appears definitely preferable. Where breeding for volume growth is concerned, hybridization and polyploid production need strong consideration, in addition to straightforward selection. Results obtained to date with aspen and other poplar hybrids as recently reviewed by Duffield and Snyder (*10*) indicate that appreciable gains may be made by this method. Where breeding for form is concerned, selection could be a very powerful tool, not only by itself, but also in combination with hybridization. Thus, it appears that in quaking aspen the most effective improvement can be expected from a program applying a variety of breeding methods properly balanced with respect to the improvement goals.

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Effect of pH and Alum Loading on the Activity of Polyacrylamide-Type Flocculants in Papermaking Furnishes

JOHN L. DATE and JOHN M. SHUTE

Laboratory work with polyacrylamide-type flocculants in paper machine furnish shows the performance of these polymers to be greatly affected by the alum loading and pH. The use of these flocculants with proper alum loadings and within a certain pH range was found to greatly increase freeness and drainage rates of pulp. Increases of 200–300% in freeness values on pulp with an initial Canadian Standard freeness of 100 ml. are achieved at very low polymer loadings. This work sheds some light on the mechanism of aluminum compounds in papermaking furnishes. Within the optimum pH range, aluminum compounds apparently act as linking agents between the anionic fiber and organic matter and the comparatively nonionic polyacrylamide.

THE USE of polyacrylamide-type flocculants is already widespread for filler retention aids both on the paper machine and in savealls. The activity of the polymers was found to vary considerably from mill to mill and it was decided to embark on a laboratory program to determine the effect of variables in the paper machine system.

As always in problems of this nature, it is difficult to evaluate machine conditions in the laboratory. This is particularly true where dilution is a factor since much of the laboratory equipment requires the use of furnish at higher dilutions than is generally found in machine headboxes.

The Canadian Standard freeness tester proved to be a valuable aid in this work. It was found that the increased freeness due to the effectiveness of the retention aids could be used as a measure of their activity. This is visually apparent. There is also a decrease in solids in the freeness tester filtrate as the freeness increases. Consistencies used in the freeness tester are of the same order as that on the paper machine.

The use of the freeness test as a measure of the flocculant's effectiveness may seem unusual since frequently there is a decrease of the apparent wire freeness upon the application of these polymers on a paper machine. When the polyacrylamide flocculant is first applied to the machine, the couch vacuum jumps, and over a short period drops as the white water solids are decreased to a lower level. At equilibrium, the final couch vacuum will be higher or lower than before depending upon the previous loss of solids from the system and the resulting pickup. If very little solids had previously been lost from this system, then the vacuum will be lower than before the application. If considerable solids had previously been lost from the system, and are being recovered with the flocculant, the couch vacuum will likely be higher than formerly and very likely the basis weight also. When conditions on the machine are close to optimum for the flocculant's activity, the apparent wire freeness will likely be greater than previously, regardless of the increased pickup.

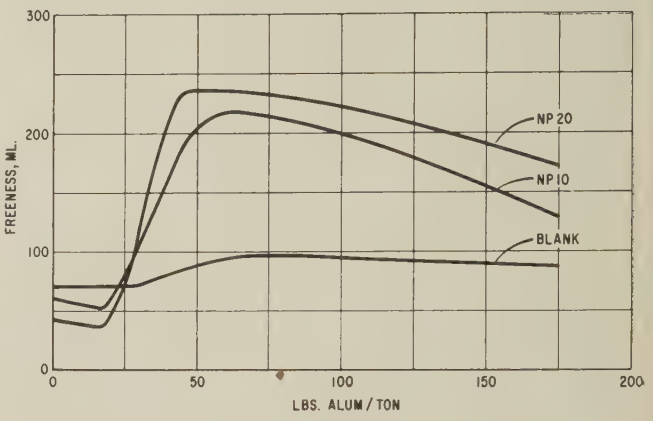

Fig. 1. Freeness versus alum loading; 2 lb. polymer per ton, newsprint pulp

PROCEDURE

The procedures used in the freeness tests were accord-

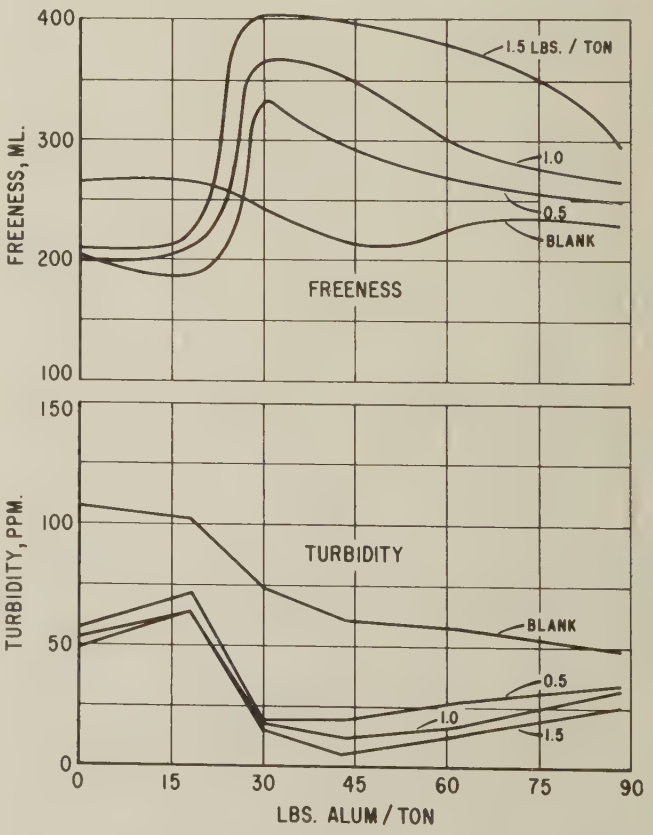

Fig. 2. Freeness and turbidity versus alum loading NP20, clay-filled pulp

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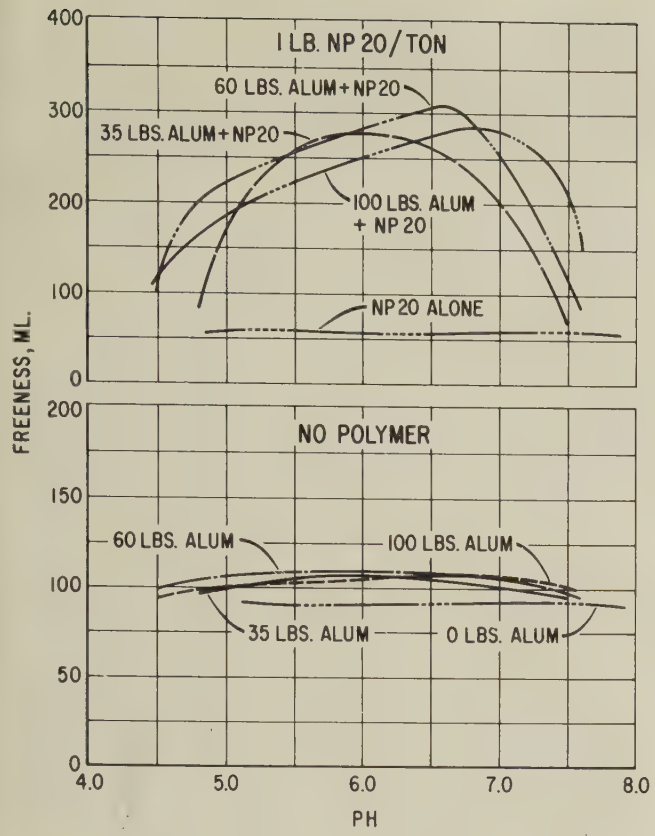

Fig. 3. Freeness versus pH, newsprint pulp

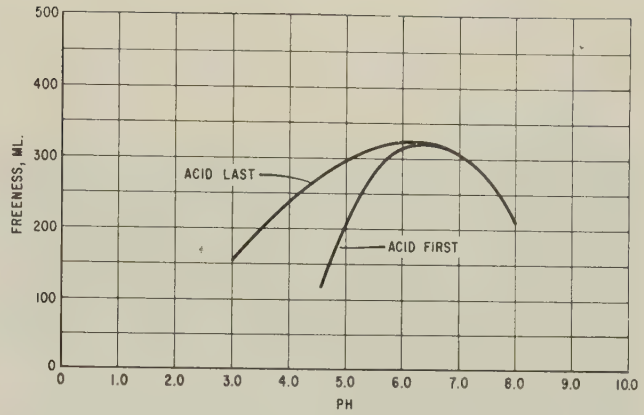

Fig. 4. pH adjustment before and after alum addition; 1 lb. NP20 per ton, newsprint pulp, 45 lb. alum per ton

ing to TAPPI Standards. Generally, alum and pH adjustments were made first on the furnish, then 0.05% solution of polyacrylamide was added with just sufficient agitation to disperse the polymer. Much of the work covered in this paper was done using newsprint and titanium dioxide and clay-loaded sulphite furnishes. Similar results were obtained on all pulps. The water used for slurrying the pulp had a hardness of 80 p.p.m. and a pH of 8.7.

EXPERIMENTAL

Initial work was carried out with various alum loadings. Figure 1 shows the effect on the freeness tests as the alum loading is increased, using 2 lb. of polyacrylamide per ton of pulp. Polyacrylamide polymers used in this work are those produced by The Dow Chemical Co. and designated as Separan® NP10 and Separan® NP20. The NP20, being of a more selected polymer range and structure, is more effective than NP10. The pulp used was newsprint furnish with an initial freeness of 70 ml. C.S. On the addition of the polymers without alum, the freeness drops. The more effective the polymer is, the greater this freeness drop. These polymers alone apparently act as dispersants on fiber slurries. At around 20 lb. of alum per ton, the freeness increases rapidly until a maximum is reached at about 50 to 60 lb. per ton. Beyond this point, this freeness falls off slowly where the pH becomes less affected by more alum addition.

The effect of varying alum loadings at three different polyacrylamide additions on clay-loaded sulphite pulp is demonstrated in Fig. 2. Here, as with newsprint, a very rapid rise in freeness is noted at 20 to 30 lb. of alum per ton. Turbidity tests on the freeness tester filtrate show a decrease in the solids content as the freeness increases.

Further work was carried out on newsprint furnish to check the effect of pH by the addition of sulphuric acid or caustic before the alum addition. Figure 3 shows with 35 lb. of alum per ton, a maximum effect at a pH of 6 with a dropoff in the activity at 4.6 and 7.4. With higher alum loadings, the maximum effect of the flocculant takes place at a higher pH. There is a maximum amount of alum beyond which any further increase, regardless of the pH, is detrimental. This is very likely due to the larger quantities of hydrate becoming a factor in slowing the stock down. At alum loadings below 20 lb. per ton, there is a rapid dropoff in the activity of the flocculant regardless of the pH.

Figure 4 shows the effect of adding the acid or base before or after the alum for pH adjustment prior to the polyacrylamide addition. The order of addition of base and alum are shown not to affect the activity of the flocculant. However, when acid precedes alum, there is a decrease in activity.

Photomicrographs (Fig. 5) of furnishes containing titanium dioxide demonstrate that the action of the polyacrylamide with alum is that it causes the pigment to adhere to the fibers. In a similar photomicrograph (Fig. 6) of an unloaded groundwood and sulphite mixture, it is seen that the polyacrylamide causes the fines to be attached to the longer fibers. Figure 7 shows flocculation and fixation of rosin size with the polyacrylamide.

The order of addition of the alum and the polyacrylamide is very important. If the polyacrylamide addition precedes the alum, very little flocculation results. Also, any pH adjustment on the stock should take place before the polyacrylamide addition or its activity is greatly limited. If the stock is to be diluted, it is necessary that the alum be added directly to the stock either before or after dilution and not to the dilution water, particularly if this is on the alkaline side.

MECHANISM OF ACRYLAMIDE-TYPE FLOCCULANTS IN MACHINE FURNISH

At first it was thought that the action of the polyacrylamide polymers in pigmented furnish was that it increased retention by flocculating the pigment which was subsequently trapped between the fibers. The photomicrographs (Fig. 5) show that actually the pigment is attached to the fiber with the Separan. This can also

be seen by the naked eye. For attachment of the pigment to the fiber, aluminum compounds apparently provide the linking agents between the polyacrylamide and the anionic fiber.

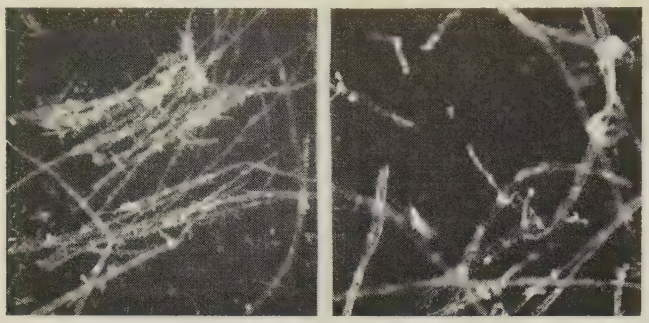

Fig. 5. Photomicrographs showing attachment of titanium dioxide to sulphite fibers with alum and polyacrylamide

It appears that one or both of two reactions take place with the alum. First, the cationic aluminum hydrate forming in contact with the fibers and organic materials becomes attached to them and provides cationic islands for linkage to the comparatively nonionic polyacrylamide. This sounds feasible; however, it should be noted that if the aluminum hydrate is first formed in dilution water before the addition to the pulp, very little activity will result when the polyacrylamide

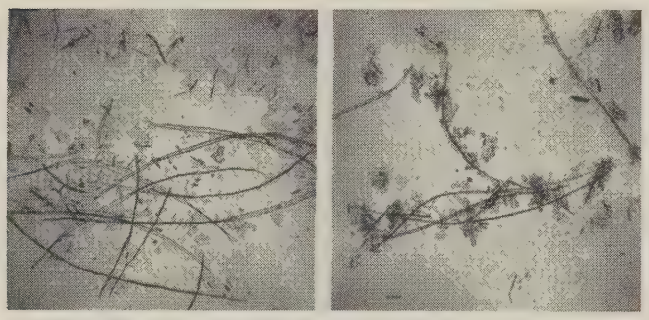

Fig. 6. (Left) Groundwood and sulphite fibers plus alum. (Right) Groundwood and sulphite fibers plus alum and polyacrylamide

is applied. This would indicate a second reaction in that the mechanism is a reaction during the stage of aluminum hydroxide formation between the alum and the fiber, thus providing a chemical linkage. This includes interaction between aluminum ions and fibers. Figure 4 indicates that this reaction is not easily reversible.

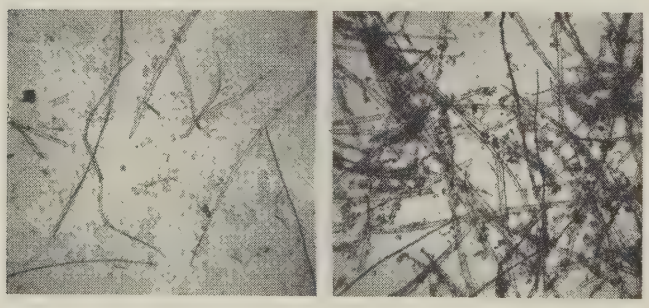

Fig. 7. (Left) Furnish containing rosin size and alum. (Right) Furnish containing rosin size, alum, and polyacrylamide—increased clarity due to agglomeration.

DISCUSSION OF RESULTS

It is quite apparent that the alum loading and pH are vital to the activity of the polyacrylamide in papermaking furnishes. Laboratory results also show that alum addition and pH adjustment should take place previous to the polymer addition. On the paper machine, the effect of alum and polymer buildup and the best points of addition for the alum or base if necessary are not known. With most of the alum being added at the fan pump, there may not be sufficient time for this material to disperse and react before the polyacrylamide is added.

The flocculant is added as a 0.05% solution to the machine headbox generally at several points so that rapid dispersion will result. After dispersion, it is desirable that the flocs not be subjected to high agitation before reaching the slice.

Flocculation is generally thought to be something undesirable on a paper machine. It should be kept in mind, however, that a loose floc held together by electrical forces is different than the knotlike flocs due to long fibers. It is believed by the authors that dispersion is actually achieved in the former by keeping all components of a machine furnish uniformly suspended or dispersed in large loose flocs. With the use of this flocculant on some paper machines producing light papers, the headbox stock has been noted to take on acurdled appearance without harming the formation.

Since the mechanism of these flocculants as retention aids is that they cause suspended materials, including fiber fines, to be attached to the fibers, they should reduce two-sidedness of a sheet. In the case of pigment, it is likely that the alum, pigments, and polyacrylamide can be applied in such a manner as to increase fiber attachment and decrease straight pigment flocculation. In this manner, greater mileage from the pigment or loading material may be achieved. The use of this polymer to bring about fiber attachment may find utility for incorporation of anionic materials into paper.

The use of polyacrylamide as a freeness improver may allow utilization of materials that tend to slow the machine down so that their use is not economical. It could conceivably be used to free up deinking sludge so that it would drain on a paper or board machine or on a wet lap machine.

CONCLUSIONS

Alum is a necessary component of paper machine furnish utilizing polyacrylamide for increasing retention on the wire. Compounds and ions forming from the alum provide the linking agents between the anionic fibers and other suspended material and the comparatively nonionic polyacrylamide.

For the maximum activity of the polymer, the pH is critical. The optimum pH varies according to the alum loading. Within alum loadings of 2 to 3% on the fiber, a pH around 6 is desirable.

Low loadings of polyacrylamide flocculants will greatly increase the freeness of pulp. Freeness increases using the Canadian Standard freeness tester, of 200 to 300% can be obtained providing conditions of alum loading and pH are optimum.

Experiences in the Manufacture and Use of All-Synthetic Drier Felts

EDWARD RACE

A survey is given of experiences in the use of 700 all-synthetic drier felts supplied to 140 paper mills in 19 countries. They have operated on machines producing every class of paper, and at speeds of up to 2000 f.p.m. On the basis of felt cost per ton of paper produced, compared with woolen or cotton drier felts, only 6% of all of the all-synthetic felts have been accounted too costly. Compared with synthetic-reinforced cotton felts, however, 25% of the all-synthetic felts have proved more costly. Results obtained on machines clothed entirely with all-synthetic drier felts confirm that, when the physical properties of the felt are matched to the drier section conditions, all-synthetic felts exhibit more efficient water removal properties than felts made of natural fibers. There is evidence that, even when only one or two positions are clothed with all-synthetic felts, a saving in steam consumption can be effected. Greatly improved evenness of drying across the sheet is commonly reported, and the evidence indicates that this is due to high capillarity in the across-machine direction. The fact that the edges of the all-synthetic felt run free from oil contamination enables the production of a sheet of maximum deckle.

In the manufacture of press felts, the use of synthetic fibers, up to the present almost exclusively in blends with wool, is a well-established practice throughout the papermaking world. Indeed, immediately nylon became available, most woolen felt manufacturers were eager to exploit its properties in the production of felts giving longer service life. Similarly, when polyester fibers appeared (chronologically, "Terylene" in England and "Dacron" in the United States), they were quickly evaluated and allotted a place in the woolen felt manufacturers' scheme. For many years now, a high proportion of the press felts manufactured by progressive felt makers throughout the world have contained blends of polyamide or polyester fibers, or both, with wool, and development work in the use of these synthetics still continues.

In the case of drier felts, the story of the use of synthetics has been somewhat different. In England, research and development work in this field began at the same time as, and ran concurrently with, similar work in the press felt field. As a result, and after initial small-scale assessments, bulk trials of drier felts containing synthetic materials began in early 1949. Thereafter, developments rapidly followed one another with results which, from a service life point of view, were far more spectacular than those which had been, or are even now, produced in the woolen press felt field. It is now many years since the largest manufacturer of drier felts outside the United States decided that all-cotton drier felts must be regarded as economically obsolete, and for more than 5 years, this manufacturer has produced a range of drier felts, the synthetic contents of which vary from 10 to 100%.

In United States, developments in the use of synthetic fibrous materials in drier felts appear to have started much later and progressed more slowly than in England. Indeed, it is probably true to say that it is only within the past two years that the correct exploitation of synthetic fibers and filaments in cotton and asbestos-cotton drier felts has resulted in the very substantial increase in felt life which has been experienced for at least five years in the rest of the Western World. Experience in the use of all-synthetic drier felts in United States has been very limited, the greater proportion of the few which have been run successfully having been supplied from England.

There is probably one major reason for the different rates of development of drier felts containing synthetic materials in United States and Europe. In the former country, no maker of woolen press felts manufactures any drier felts apart from the small number of woolen drier felts which are used in the production of very fine papers; and no maker of cotton and cotton-asbestos drier felts manufactures woolen press felts. In England, on the other hand, the largest manufacturers of woolen felts are also manufacturers of cotton and cotton-asbestos drier felts. Consequently, developments in the use of synthetic fibers in woolen felts, which proceeded simultaneously in United States and England, were, from the outset, naturally accompanied in England by the incorporation of synthetic materials in drier felts. Although, because of the different functions performed by wet felts and drier felts, the application of the synthetics took different paths, the fact that both types of felt were produced, figuratively at least, under the same roof, gave added incentive in both spheres to research and development of the use of synthetic fibers.

An account of recent advances in papermachine drier felts based on the incorporation of synthetic yarns and filaments has already been published (*1*). That paper contains little more than passing reference to all-synthetic drier felts, being more concerned with felts containing from 10 to 50% of synthetic materials. The present communication attempts to give a broad factual survey of experiences in the use of all-synthetic drier felts on paper machines outside United States. The survey is limited to felts supplied by one English manufacturer, and it should be noted that the term "all-synthetic" rather than "Terylene" or "Dacron" drier felts is used. In the initial stages of all-synthetic drier felt development, a limited number of wholly Terylene felts were manufactured and used. It was soon discovered that important advantages (*2*) were obtained by the use of yarns spun from blends of

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Terylene* and nylon, and the following results refer to felts made from these blended yarns.

THE BASIC REQUIREMENTS IN DRIER FELTS

For a felt to run at all on a paper machine it must run true and straight at the speed of the machine and it must possess adequate dimensional stability. These, however, are minimum requirements and there are a number of equally important functional characteristics which vary with the machine conditions and the type of paper produced. These characteristics include efficiency of water removal, whether that water be removed as liquid or vapor, the effect on the surface finish of the sheet and, from an economic point of view, the service life of the felt as judged by the relation of its cost to the amount of paper produced while it is on the machine. For a particular paper machine and the particular conditions under which it runs, the over-all efficiency of a drier felt is dependent upon: (1) the physical and chemical properties of the raw materials from which the felt is produced; (2) the structure of the yarns from which the felt is composed; (3) the weave structure of the felt itself; and (4) the finishing treatment to which the felt is subjected.

The Physical and Chemical Properties of the Raw Materials

The nature of the fibrous materials from which a drier felt is constructed affects not only the service life of the drier felt, but also its efficiency as a water-removing agency.

The natural hydrophilic fibers, such as cotton and other cellulosic fibers and wool and other protein fibers, have an avidity, albeit limited, for water by reason of their chemical reactivity. Consequently, they attract water, whether in liquid or vapor phase, until this activity is satisfied, and only then will the fibers begin to feel wet to the touch. On the other hand, water so absorbed requires more energy for its release than that which is purely physically held. The synthetic hydrophobic fibers absorb and retain very little water by natural regain, virtually all absorption and retention being physical.

Thus, at the first sections of the drier part of a paper machine where transfer of liquid water from the sheet to the felt can be expected, a cotton drier felt will absorb this water chemically, by reason of its natural regain, and physically through the interfiber capillaries in the felt. An all-synthetic felt, on the other hand, absorbs the water only by capillary attraction. Because of the circular cross section, smooth and parallel surfaces and greater length of the fibers of a synthetic yarn, its interfiber spaces are more perfect capillaries than those of a cotton yarn in which the fibers are collapsed tubes of irregular cross section. Because of this higher capillarity, a synthetic yarn physically absorbs more water more rapidly than a similarly constructed cotton yarn. Laboratory tests suggest, and practical use confirms, that the enhanced capillarity of the fiber bundles in an all-synthetic felt more than outweighs the greater hydrophilic character of the fibers of an all-cotton felt.

At all sections of the drier part of a paper machine, and particularly in the sections after the first, water is removed from the sheet as vapor. Apart from that which is dissipated to atmosphere at the draws between the cylinders, this vapor must either pass through or be condensed in the drier felt, and, if the latter is not to become water-logged, must sooner or later be dissipated as vapor into the atmosphere. Absorption of moisture by hydrophilic fibers, such as cotton, causes appreciable swelling of the fibers, resulting in up to 45% increase in volume. This, in turn, causes a corresponding decrease in the vapor permeability of drier felts woven from cotton yarns. The synthetic hydrophobic fibers, on the other hand, exhibit virtually no swelling when wet, and any loss in permeability sustained by all-synthetic felts in service is due to water held in the interfiber capillaries.

That the decrease in permeability due to the swelling of cotton fibers in a cotton drier felt is greater than that due to the physical absorption of water into the interfiber capillaries of an all-synthetic felt is illustrated in Fig. 1 which shows the relationship between permeability and moisture content of an all-cotton felt and an all-synthetic felt of identical structures, similar weights per unit area, and similar initial permeabilities.

In the case of the all-cotton felt, a relatively small increase in moisture content results in rapid swelling of the fibers with a consequent appreciable decrease in permeability. The maximum rate of swelling occurs up to 20% moisture content, and thereafter, up to approximately 40% moisture content, the water continues to be absorbed physico-chemically with only slight increase in swelling and consequent slight decrease in permeability. Above 40% moisture content, water is physically held by capillarity and the decrease in permeability is extremely rapid until, when a moisture content of about 62% is reached, the permeability of the felt is only about 15% of its initial value. Thereafter, the low rate of decrease in permeability is evidence of the felt becoming waterlogged.

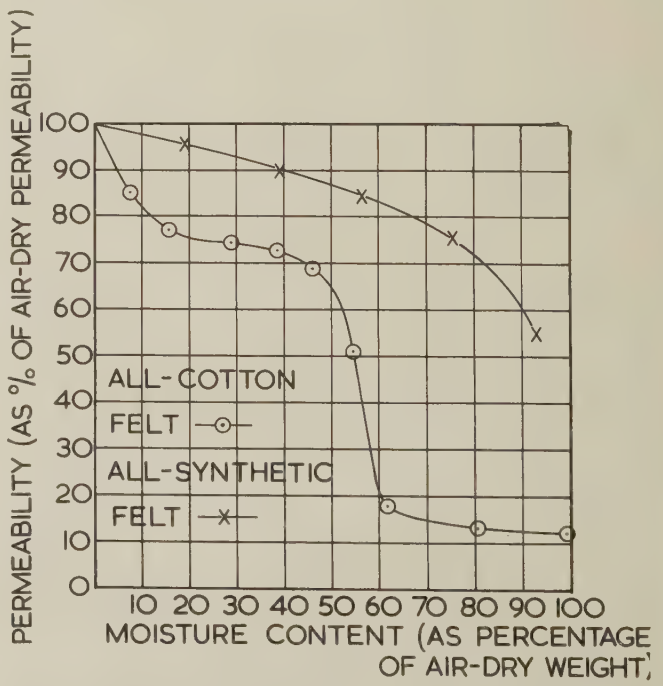

Fig. 1. Relation between vapor permeability and moisture content

* In order to avoid confusion in the minds of American readers, hereafter the polyester fiber used in all-synthetic drier felts will be referred to as Dacron. The normal types of I.C.I.'s polyester fiber, Terylene, and de Pont's polyester fiber, Dacron, have virtually identical physical and chemical properties. It should, however, be borne in mind that Terylene, and not Dacron, was used in the manufacture of all the felts in this review.

In the case of the all-synthetic felt, no swelling of the fibers occurs, the moisture, at whatever content, being held solely by interfiber capillarity. Consequently, decrease in permeability with increasing moisture content follows the simple relationship shown in Fig. 1. Increasing moisture content adversely affects the permeability much less in the case of the all-synthetic felt than in the case of the all-cotton felt.

It is interesting to note that, on drying the two felts after they had been wetted to approximately 100% moisture content, the permeability of the all-cotton felt was restored to 85% of its initial value, whereas that of the all-synthetic felt recovered to its full initial value. This is explained by the fact that the fiber swelling which occurs when the cotton felt absorbs moisture causes greater yarn corrugation in the woven structure which does not wholly recover when the fabric is dried. No fiber swelling, no yarn or fabric distortion, and therefore no permanent decrease in permeability occurs due to wetting and redrying the all-synthetic felt.

If a drier felt is not to become waterlogged (that is, run too wet), it is essential that the water absorbed from the sheet be dispersed to the atmosphere during the return run of the felt to the driers. This is normally achieved by unassisted drying, by contact of the felt with a steam-heated cylinder, or, more rarely, by sucking or blowing hot air through the felt during its return run. Whichever method of felt drying is used, the rate of drying of the felt is obviously important since upon it will depend the moisture content of the felt when it returns to the paper-drying cylinders.

Figures 2 and 3 show the drying rate curves of samples of all-synthetic and all-cotton felts, identical in structure and similar in weight per unit area, dried at 212, 140, 104, and 68°F., in a large oven fitted with a fan for slow replacement of air. This simulates "unassisted" drying at different ambient temperatures and demonstrates that, at higher moisture contents the drying rate of the all-synthetic felt is very slightly greater than that of the all-cotton felt, and at moisture contents below approximately 25% (i.e., in the region most likely to be encountered by a drier felt in service), the drying rate of the all-synthetic felt is appreciably greater than that of the all-cotton felt, especially at air temperatures not higher than 140°F.

Figure 4 shows the drying rate curves of the felts dried by contact of one face with a rotating steam-heated cylinder, the surface temperature of which was 240°F. The curves are of the same type as those for air-drying and illustrate that the drying rate of the all-synthetic felt is slightly greater than that of the all-cotton felt at the higher moisture contents, and appreciably greater at the lower moisture contents.

Samples of felts were dried by blowing air at 240°F. through them, the air velocity at the face of the felt being 1000 f.p.m and its pressure 0.27 in. water gage. Figure 5 shows the drying rate curves. Above approximately 25% moisture content, the all-synthetic felt and the cotton felt have virtually the same drying rate. Below 25% moisture content, however, the drying rate of the all-synthetic felt is nearly twice that of the cotton felt. It is interesting to note that, under the conditions adopted, the drying rate achieved by passing hot air through the felt is more than twice that of drying by contact heating. This relationship is, of course, depend-

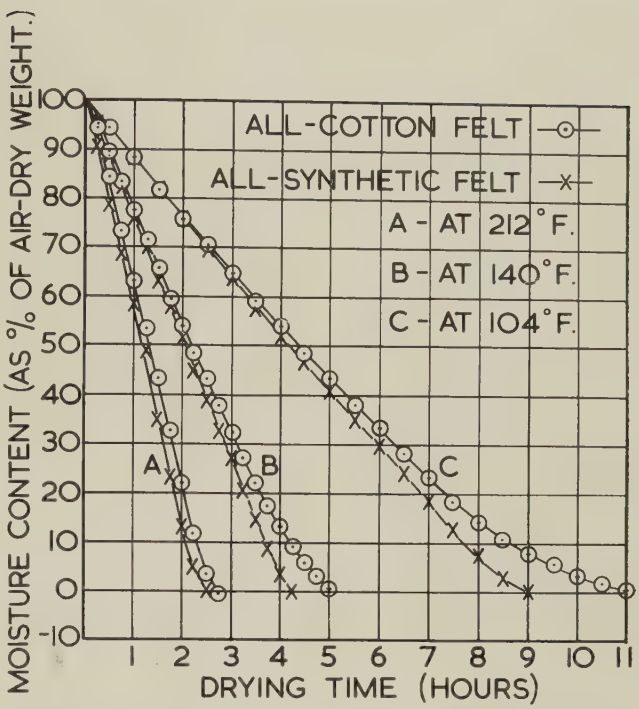

Fig. 2. Rate of drying in air at various temperatures

ent upon the permeability of the dryer felts and the humidity of the air in the vicinity of the felts.

Thus, because of the physical nature of the fibers, it is to be expected that, for a given structure of drier felt, an all-synthetic felt will exhibit greater water-removal efficiency than an all-cotton felt because the former (1) more readily absorbs liquid water by capillarity, (2) retains a much higher vapor permeability at all moisture contents encountered in a drier felt during its service life, and (3) redries more rapidly during its return run to the paper-drying cylinders.

The physical and chemical properties of the fibers of which a drier felt is composed naturally have a major influence on the service life of the felt. The agents mainly responsible for degradation in drier felts are

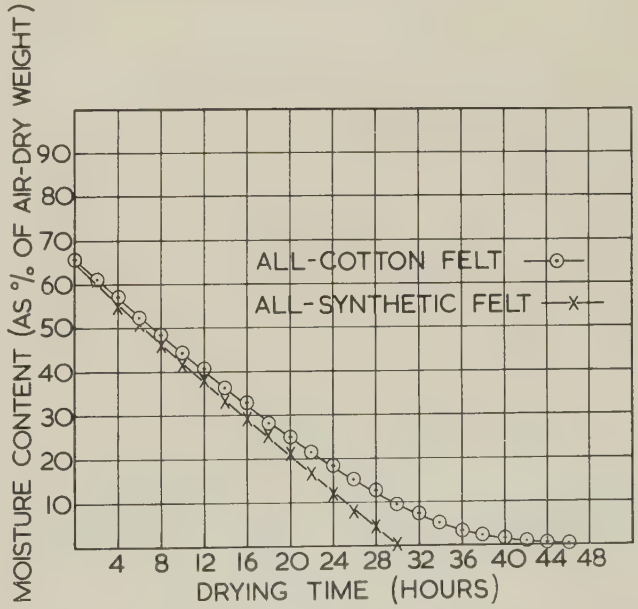

Fig. 3. Rate of drying in air at 68°F.

heat, moisture, flexural disintegration, abrasion, acid, and, in the case of cotton, small amounts of iron oxide. The effects of the various degrading influences are, of course, interrelated. For example, if a drier felt is degraded by heat, it will be more susceptible to flexural disintegration. Alternatively, if the fibers of the felt are degraded by hydrolysis, the felt will be more susceptible to mechanical abrasion. Thus, the ideal fiber is one which is resistant to all the degrading influences to which the felt is subjected.

Both nylon and Dacron are superior to cotton in strength, abrasion resistance, flexural endurance, and resistance to heat, iron contaminants and acid. Nylon has greater abrasion resistance, flexural endurance, and is less susceptible to hydrolysis than Dacron. Dacron, however, is outstandingly superior to nylon* in heat resistance.

Thus, because of the physical nature of the fibers, it is to be expected that, under normal paper-machine dry end conditions, an all-synthetic drier felt, whether composed of nylon or Dacron or both, will exhibit considerably longer service life than that of an all-cotton felt.

The Structure of the Yarns

For a drier felt composed of a given synthetic hydrophobic fiber, the structure of the yarns can influence dimensional stability, water-removing efficiency, and service life. The variables of yarn structure are: the count (i.e., weight per unit length) of the single yarn, the twist (i.e., turns per inch) in the single yarn, the number of single yarns which comprise the doubled yarn (and hence the count of the doubled yarn), the twist in the doubled yarn (and hence the resultant twist in the single yarn).

Each of the above variables influences the behavior of the drier felt on the paper machine. Thus, the higher the twist in a yarn, the lower is its elastic modulus, and yarn twist therefore affects dimensional stability. On the other hand, a high twist results in greater flexural endurance, but lower strength, and therefore yarn twist affects service life. The capillarity of the individual yarns, and therefore of the felt as a whole is related to the twist in the yarns, there being, for a given yarn count, an optimum twist below or above which the capillarity decreases. Thus, for a position on a paper machine at which the water content of the sheet is such that liquid water can be transferred from sheet to felt by capillarity, the structure of the yarn influences the water-removal properties of the felt.

Unfortunately, a yarn structure which is optimum for one beneficial effect is not necessarily optimum for another, and it becomes necessary to adopt a compromise in which, for a particular application, the most desirable characteristics are emphasized at the expense of less valuable characteristics.

The Structure of the Felt

It is obvious that, having selected for physical, chemical, and economic considerations the fiber or mixture of fibers from which a drier felt is to be made, the structure of the felt itself is of paramount importance in determining dimensional stability, water removal efficiency, service life and, in many instances, the surface characteristics of the sheet produced. Included in the structure of the felt, and of almost equal importance to the weave pattern adopted, is the density of the yarns in both the machine and across the machine directions.

A dimensionally stable drier felt is one which not only

* Refer to "developments" later in text.

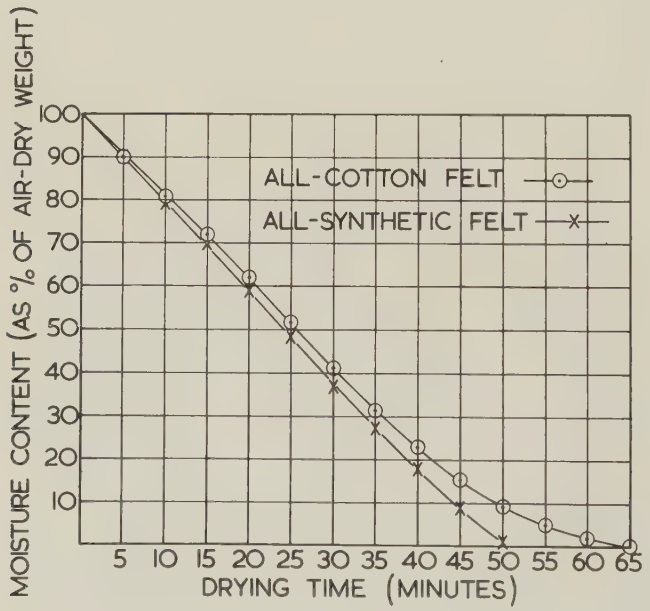

Fig. 4. Rate of drying on steam-heated cylinder at 240°F.

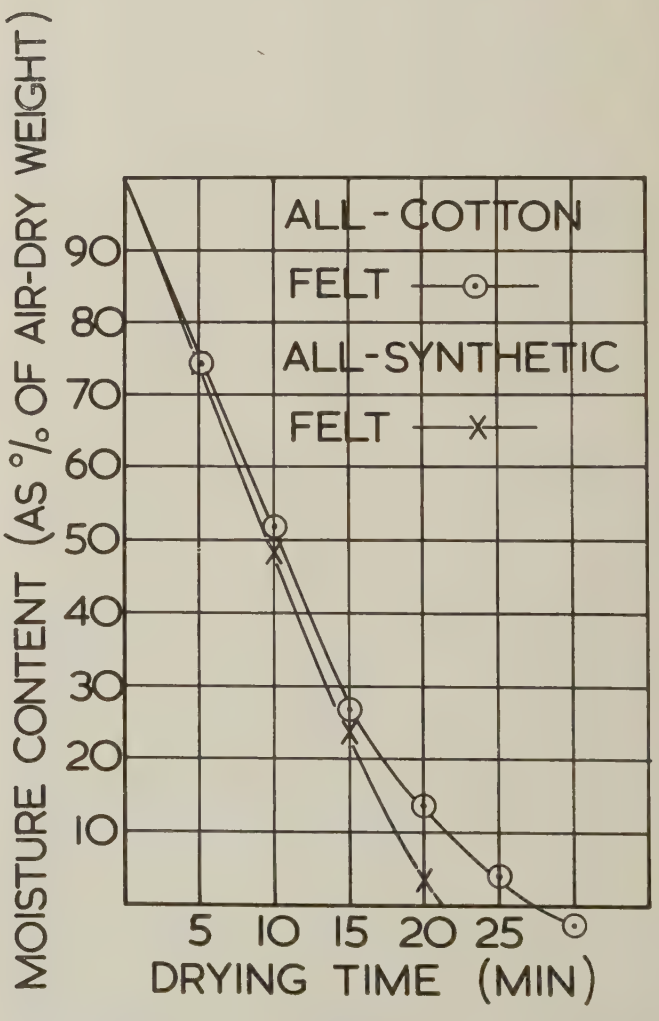

Fig. 5. Rate of drying by blowing air at 240°F. through the felt

maintains its required length and width under the conditions appertaining on the drying section which it clothes, but also one which shows no tendency to wrinkle or crease under these conditions. The factors in felt manufacture which influence the degree of dimensional stability are: (1) the structure of the yarns of which the felt is composed, (2) the weave structure of the felt, (3) the yarn densities in both directions, (4) the methods adopted in weaving the felt, and (5) the finishing treatments to which the felt is subjected.

The weave structure of the felt must be related in no small degree to the type of paper being manufactured. A suitable structure having been chosen for a particular class of paper, it must be ascertained that the speed of the machine, the width of the felt, the running tension of the felt and the moisture conditions on the drying section are compatible with the selected structure.

The yarn densities in the felt have a profound influence on its dimensional stability, and, for a given felt structure, they must be related to the machine conditions enumerated above. A relatively loosely woven structure might have adequate dimensional stability on a narrow, slow running machine, but be totally inadequate on a wide, high-speed machine.

The elastic moduli of yarns spun from synthetic fibers differ greatly from those of cotton yarns. Because of these widely differing properties it was found early in the manufacture of all-synthetic felts that, irrespective of yarn or felt structures, considerable modifications in weaving techniques had to be adopted in order to ensure the production of felts uniform in tension across their width, and therefore of felts which would be capable of running true and straight on machines of all widths and at all operating speeds.

The rate of dissipation of moisture from the sheet to the atmosphere at any section of the drier part of a paper machine is influenced by the structure of the drier felt. There is abundant evidence confirming the belief that, on the early sections, a proportion of the water is removed by liquid transfer from the sheet to the felt. On these sections, high capillarity through the drier felt is obviously desirable, and this is best achieved if a high proportion of the yarns in the felt pass directly from the working face to the back. Under identical conditions, an all-synthetic felt absorbs more water more rapidly than an all-cotton felt of identical structure, although it must be borne in mind that, for maximum efficiency, the felt should return as dry as possible to the paper-drying cylinders. On later sections, where dissipation of moisture as vapor from the sheet is virtually the sole method of water removal, the vapor permeability of the felt influences drying efficiency. The vapor permeability of an air-dry all-synthetic felt is slightly greater than that of an air-dry cotton felt of the same construction and weight per unit area, but, as has already been noted, the decrease in permeability with increasing moisture content is much less in the case of the all-synthetic felt than in the case of the all-cotton felt. However, the actual weave structure of the felt has a more profound influence on its vapor permeability than the fibers of which the felt is composed. For example, according to structure and independent of the fibers from which the drier felts are made, vapor permeabilities can vary from 0.01% to 2.5% of the permeability of the perfect orifice.

The weave structure of a felt and the yarn densities in the felt influence its service life. Since flexural failure is one of the main causes of felt deterioration, it follows that the structure which, under given conditions on a drier section, gives maximum flexural endurance, will tend to give maximum service life. Furthermore, in a felt which is composed of hydrolyzable fibers, rapid dispersal of moisture to the atmosphere and of injurious chemicals throughout the felt is conducive to longer felt life, and the rate of liquid and vapor dispersal is dependent largely upon the structure of the felt.

The Finishing Treatments Applied to the Felt

Because of the difference in elastic properties between synthetic materials and cotton, it was recognized early in the development of the all-synthetic felt that the preshrinking and normalizing treatment, so essential to the stable running of all-cotton and predominantly cotton drier felts, was inadequate as a finishing treatment of all-synthetic felts. A more efficient form of heat setting, coupled with the established normalizing process, was applied to the great majority of felts, the performances of which are discussed in this paper.

The above discussion on the basic requirements in drier felts, with special reference to all-synthetic felts, has been given at some length in order to emphasize one point of paramount importance: the success or failure of a drier felt in service, whether the performance be based on length of life, cost per ton of paper, steam consumption per hour or per ton of paper, or quality of the finished product, or on a combination of these data, is dependent upon many factors concerned with the manufacture of the felt as well as with the choice of raw material used in its construction. A papermaker does not consider that wool is useless as a raw material for press felts because he found a particular press felt inefficient on his machine. Similarly, he cannot condemn all-synthetic drier felts in general because a particular type of all-synthetic felt was found unsuitable on a section of the drier part of his machine. Conversely, the success of *one type* of all-synthetic drier felt under given conditions does not ensure the success of *any type* of all-synthetic drier felt under the same conditions.

It is for this reason that the company with which the author is associated has found it necessary to manufacture and supply 18 different types of all-synthetic drier felts and to exercise careful judgment in matching the type of felt to the machine conditions and the class of paper manufactured.

From the fact that this survey is concerned with 700 all-synthetic drier felts supplied to 140 paper mills in 19 countries, it is apparent that the manufacture and use of these felts have passed the trial stage and have emerged as an item of normal and permanent production. Naturally, this does not mean that development work has ceased any more than it has reached finality in the case of the much longer established cotton drier felt.

The all-synthetic drier felts which have operated or are operating on paper machines have clothed machines of all widths. Thus, of the felts manufactured, 6.6% have been for machines under 75 in. wide, 25.6% for machines 75 to 100 in. wide, 53.7% for machines 100 to 150 in. wide, 8.6% for machines 150 to 200 in. wide and 5.5% for machines over 200 in. wide. The fact that

these percentages correspond very closely to those of the total number of machines of these widths in the markets in which the felts have been supplied suggests that the machines clothed by all-synthetic felts represent a true cross section of all the fourdrinier machines in these markets.

Of the total number of felts, 45.8% have been manufactured in structures giving a smooth, weft flushed working face suitable for use on machines producing the finest papers; 32.1% of the felts have been in three-layer structures, producing general purpose felts which have been employed on machines manufacturing medium fine to medium coarse papers; the remainder of the felts (22.1% of the total) have been various types of duplex (i.e., two-layer) fabrics used mainly in the production of coarser papers, newsprint, and kraft.

The above proportions should not be taken to indicate that all-synthetic drier felts are more applicable to machines producing fine papers. They are, indeed, only an illustration of the fact that, chronologically, the trends have been (1) for the all-synthetic felt, although manufactured on the principles of the cotton drier felt, to be used to clothe drier positions previously clothed by woolen drier felts, (2) for the all-synthetic felt to clothe drier positions, previously clothed by the finer types of cotton drier felt, of machines producing medium fine papers, and (3) for the all-synthetic felt, manufactured in the most stable structures and equipped with a mechanical seam, to clothe positions on wide, fast-running newsprint and kraft machines. The evidence suggests that trend (1) is proceeding to virtual completion, rapidly in Great Britain, more slowly in other European markets. The number of all-synthetic drier felts clothing positions on machines making medium papers (trend 2) is increasing, although the statistical evidence indicates the possibility of stability being reached with over 80% of the drier positions still clothed with cotton (or, more correctly, synthetic-reinforced cotton) drier felts. The third and most recent trend, the use of all-synthetic drier felts on high-speed newsprint and kraft machines, is in its early stages. Although more than 60 all-synthetic drier felts have been supplied for use on high-speed newsprint and kraft machines, some have not yet been installed, most are still in service, and, in any case, it is only within the past 18 months that the structure most likely to succeed has been adopted. While the results to date are most satisfactory, no indications can be gathered as to the total extent to which all-synthetic felts are likely to be used on the high-speed machines.

Ideally, the performance of a drier felt should be based upon its cost per ton of paper, the steam consumption in the paper-drying cylinders which it clothes and in any felt-drying device, and the surface characteristics of the finished sheet of paper. The service life of the felt in terms either of cost per ton or of running time measures itself, and, unfortunately, is, in virtually every paper mill, the sole criterion of performance. Unless the water removal efficiency of the felt is unmistakeably poor, on the rare occasions on which reference to it is made, those references are most often in casual, qualitative terms. Consequently, in this survey, more can be reported on the performance of all-synthetic felts as based on service life than on water removal efficiency.

THE SERVICE LIFE OF ALL-SYNTHETIC DRIER FELTS

Traditional Woolen Drier Felt Positions in the Production of Fine Papers

Because of their initial cost, it was probably inevitable that the first stage in the development of all-synthetic drier felts should be their use on positions traditionally clothed by woolen drier felts. In England, this meant the clothing of the drier parts of machines producing cigarette, condenser, carbonizing and similar lightweight tissues, banknote and security papers, fine esparto papers, glassines, greaseproofs and tracings, photographic, technical and process papers, and similar products in the fine paper range. On the Continent of Europe, woolen drier felts were and are used on a wider range of papers and even in the manufacture of newsprint.

To simulate the close, milled texture of the heavy woolen drier felt, the all-synthetic felts were woven with a fine, irregular sateen working face, given a hand-spliced seam and a raised surface. These felts proved successful on machines making the finest of papers, although it was soon found that for many classes of paper, the raised surface was not required and that other, slightly coarser, weave structures were adequate.

The initial cost of an all-synthetic drier felt at 6 oz. per sq. ft. is similar to that of a woolen drier felt at 10.5 oz. per sq. ft., and therefore, from a felt cost point of view, the service life of the synthetic felt had to equal or excel that of the woolen drier felt.

If four of the earliest felts which proved to be dimensionally unstable, three felts which sustained rapid chemical degradation and two felts the spliced seam of which marked the paper, be discounted, of the all-synthetic felts which, replacing woolen drier felts, have completed their service lives, the following results in terms of life have been obtained:

More than 4 times life of woolen drier felt	4.7%
3–4 times life of woolen drier felt	10.4%
2–3 times life of woolen drier felt	34.0%
1–2 times life of woolen drier felt	28.3%
Equal to life of woolen drier felt	15.1%
0.75–1 times life of woolen drier felt	7.5%

Thus, from the standpoint of drier felt cost, more than three quarters of all the all-synthetic felts substituting woolen drier felts have proved economically sound, and nearly half of them have given more than double the life of felts which were initially of equal cost. About 15% of the all-synthetic felts have just equalled woolen drier felt life, and in only 7.5% has the life fallen below that of the woolen drier felt.

Traditional Cotton Drier Felt Positions in the Production of Papers at Speeds below 1000 f.p.m.

The assessment of the use of all-synthetic drier felts on machines, normally clothed with cotton drier felts, and producing fine and medium grades of paper, has been complicated by the simultaneous great advances made in the life performance of cotton drier felts themselves. It is no exaggeration that the past five years have seen on an average, a halving of drier felt cost by the use of synthetic-reinforced cotton drier felts (*3*) in place of all-cotton felts. Consequently, comparisons of service life must take into account this increased life obtained by the use of small proportions of syn-

thetic materials, and the type of felt against which the comparison is made must be specified.

On an average, the initial cost per unit area of an all-synthetic felt is 2.4 times that of an all-cotton felt and twice that of a synthetic-reinforced cotton felt, the tendency being for the all-synthetic felt to be approximately 10% lighter in weight than the corresponding cotton felt. Thus, in order to be economically sound from the standpoint of felt cost, other things being equal, an all-synthetic felt should have a service life of at least $2^1/_2$ times that of an all-cotton felt and at least twice that of a synthetic-reinforced cotton felt.

Of the hundreds of all-synthetic felts supplied, it was inevitable, when working with a new raw material, that a small proportion should be removed from the paper machines after relatively short times because of dimensional instability, accident, or unsuspected adverse chemical conditions. When such "failures" are discounted, of the felts which have completed their normal service lives and have been discarded as "worn out," the following results in terms of life and/or cost per ton of paper have been received:

More than 10 times	all-cotton felt...6.1% synthetic-reinforced cotton felt...None
5–10 times	all-cotton felt ..7.4% synthetic-reinforced cotton felt...None
4–5 times	all-cotton felt...39.0% synthetic-reinforced cotton felt...7.1%
3–4 times	all-cotton felt...29.0% synthetic-reinforced cotton felt...24.7%
2.5–3 times	all-cotton felt...6.3% synthetic-reinforced cotton felt...29.3%
2–2.5 times	all-cotton felt...7.9% synthetic-reinforced cotton felt...14.1%
1–2 times	all-cotton felt...4.3% synthetic-reinforced cotton felt...21.0%
Less than life of	all-cotton felt...none synthetic-reinforced cotton felt...3.8%

From the point of view of drier felt cost, therefore, compared with corresponding all-cotton felts, 81.5% of those for which results are known have proved economically sound, 14.2% are borderline cases, and only 4.3% must be accounted too costly. Compared with synthetic-reinforced cotton drier felts, however, 61.1% of the total number of all-synthetic felts have been successful from a cost point of view, 14.1% are of doubtful economic worth, and 24.8% have been more costly than the corresponding synthetic-reinforced cotton felts.

It is not unreasonable to suggest that the above figures may prove to be pessimistic. Naturally, of the all-synthetic felts supplied, a relatively high proportion are, and in some cases have been for many months, in service on the paper machines. Most of these felts have been supplied during the past two years during which new techniques of manufacture and improved constructions have been adopted. The results of these modifications must, of course, await the assessments of the felts' performances, but it is reasonable from past experience to expect an increased service life from them.

Traditional Cotton Drier Felt Positions on Machines Producing Mechanical Printings, Newsprint, and Kraft

The clothing with all-synthetic drier felts of machines running at speeds in excess of 1000 f.p.m. was undertaken only after extensive trials at slower speeds. Consequently, fewer completed results are known, and a summary of service life is of little worth at this stage. However, from a general survey of those felts which have completed their service and of those felts which have been on drier sections for a considerable time and are still running, it would appear, surprisingly enough, that the proportional increase in service life at the higher speeds is greater than that on slow-running machines. The following are examples of synthetic drier felt performances on the higher speed machines:

1. On a newsprint machine on which the average life of synthetic-reinforced cotton drier felts is 4 months, all-synthetic drier felts run for 10 months with a cost per ton only 70% that of the reinforced cotton-felt.
2. An all-synthetic felt was installed in April, 1956, on a machine producing high-grade mechanical printings at 1200 f.p.m. The felt is still running after 33 months, compared with a cotton felt life of 7 months.
3. On a newsprint machine running at 1950 f.p.m., an all-synthetic felt produced 150 metric tons per kg. of felt as compared with 66 metric tons per kg. of a synthetic-reinforced cotton felt. The cost per ton of paper of the all-synthetic felt was only 65% of that of the synthetic-reinforced cotton felt.
4. An all-synthetic felt was installed at the beginning of December, 1956, on a machine producing mechanical printings at 1100 f.p.m. The felt, which is still running, had, in March, 1958 (that is, 10 months ago) produced a greater tonnage of paper than that produced by more expensive woolen drier felts.
5. An all-synthetic felt, which is still running on a newsprint machine at 1340 f.p.m., was installed at the beginning of November, 1957. It has been on the machine for 340 operating days of 24 hr. each. This uncompleted service life is already $3^1/_4$ times that of a synthetic-reinforced cotton drier felt and 6 times that of an all-cotton drier felt.
6. A kraft machine running at speeds in excess of 1000 f.p.m. has the world's largest MG cylinder clothed with all-synthetic drier felts which give a service life more than double that of heavy woolen drier felts of the same initial cost.

Most of the all-synthetic drier felts supplied for machines running at the higher speeds have not yet been in service long enough for assessments of performance to be made. The above examples, however, suggest that encouraging results may be expected.

Why the Occasional Failure?

The extended service life which the great majority of all-synthetic drier felts achieve is, as has been stated, due to the heat, abrasion, and chemical resistance of the fibers, and the flexural endurance of the felts. Examination of the used felts shows that, in most cases, the primary cause of the degradation which has necessitated their removal is hydrolysis of the Dacron, followed by mechanical degradation of the weakened fibers. This mechanical degradation generally takes the form of abrasion of the working face of the felt, and flexural rupture of the fibers of the center and back layers. Very occasionally, in the case of poorly conditioned felt rolls, the back of the felt also sustains abrasion. As can be judged from the service results above, under normal paper machine conditions, the degradation of Dacron is slow enough to enable the felt to give a profitable life.

The most spectacular life increase resulting from the use of all-synthetic felts has been that in a mill produc-

ing straw paper, brown wrappings, middles, and similar coarse products. The all-synthetic felts have consistently given lives of 11 to 12 times those of the previously used all-cotton felts. The machines have felt rolls of only 5 in. diam. with two or three "breakbacks" in each position. Examination of the used all-cotton felts after a running life of 10 weeks clearly showed that the major cause of deterioration was flexural rupture of the individual cotton fibers. The service life of 110 to 120 weeks given by the all-synthetic felts is due almost entirely to the superior flexural endurance of the synthetic fibers.

It is inevitable that, of the hundreds of all-synthetic drier felts supplied to a wide variety of paper mills, a small proportion have had to be discarded within days or a few weeks of being installed. Even when the trial felts supplied in the early stages are taken into account, surprisingly few all-synthetic felts have been removed prematurely because of excessive narrowing or stretching. Indeed, numerous papermakers regard the dimensional stability of all-synthetic drier felts as one of their major virtues, leading as it does to fewer accidents, oil-free edges, and constant length whether the drier part has a sheet running through it or not (see, for example, (*4*)).

Nevertheless, in the trial stages, most of the few felts which were prematurely discarded were removed because of one form of instability, namely, a tendency for the felt to crease or wrinkle in the machine direction. It was soon realized that, for each felt structure, there is a minimum weight per unit area (this minimum weight being closely related to the width and speed of the paper machine) below which creasing is liable to occur. Naturally, having discovered the cause, the defect was eliminated.

The only other major cause for the premature removal of all-synthetic drier felts, again an extremely small proportion of the total, has been a rapid and totally unexpected chemical degradation of the Dacron component of the felt. Dacron is a polyester, and in common with all esters, it is hydrolyzable into its component acid and alcohol. Normally, under paper machine conditions, the hydrolysis of the Dacron in the felts is extremely slow, but under conditions of extreme wetness, or when the acidity of the furnish is so low that an aqueous extract of the felt has a pH value lower than 4.3, hydrolysis can result in premature degradation of the felt. The two outstanding examples are quoted below:

All-synthetic felts were installed on the first bottom positions of two machines in the same machine house. The sheet, made from stock at pH 4.0, entered the drier section at 75% moisture and neither of the first bottom positions had provisions for felt drying. At the end of 5 weeks, the working surface of each felt was coated with a layer, about $^1/_{16}$ in. thick, of fibers so short that they were little more than dust. The felts were removed and measurements of the intrinsic viscosity of solutions of Dacron confirmed that severe hydrolysis had occurred.

An all-synthetic drier felt was run on the first bottom position of a machine on which the sheet entered the drier part at 77% moisture. The surface temperature of the first section cylinders was 313°F., there being no felt drier on this section. After 4 weeks, the felt was completely degraded, much of it having disappeared as dust. During its short life, the felt carried an amazing amount of water, pressure of the thumb on its back surface being sufficient to cause a considerable spray. A second, similar felt was tried on the same position, with the vital difference that in this case the sheet was diverted so as to by-pass one cylinder which was employed instead as a felt-drying cylinder. The result was that the felt returned to the first paper-drying cylinder relatively dry, the sheet left the section less moist than during the use of all-cotton felts, and the life of the all-synthetic felt was 59 weeks! Thus, the use of one felt-drying cylinder increased all-synthetic felt life more than fifteen-fold.

The obvious inference from these isolated examples is that, in wet drier felt positions clothed with all-synthetic drier felts, provision for adequate felt drying is essential, not only for maximum efficiency in drying the paper, but also for maximum felt life.

The Water-Removing Efficiency of All-Synthetic Drier Felts

As stated earlier, in the great majority of cases, the papermaker, or those responsible for costing in the mill, appears to be more concerned with the relation of the initial cost of a felt to the weight of paper which it produces during its operating life than with its operating efficiency in terms of water removed per unit of heat employed. Consequently, unless a felt is obviously restricting the removal of water on the section which it clothes (an observation which has never been reported in the case of any all-synthetic felt), it is only on rare occasions that comments regarding drying efficiency are received, and on even rarer occasions that quantitative results are reported.

Furthermore, there are, as yet, relatively few paper machines the drier parts of which are clothed entirely with all-synthetic felts, and consequently the full impact of their greater drying efficiency is not readily observable without recourse to quantitative measurements of steam consumption and moisture content of the sheet on individual sections clothed with all-synthetic felts.

The results reported for paper machines clothed entirely with all-synthetic felts confirm, either qualitatively or semiquantitatively, the laboratory conclusions that, assuming the use of a felt of the correct physical properties for a given drier section, the all-synthetic felt exhibits more efficient water removal properties than felts made wholly or predominantly of natural fibers. The following are examples:

1. A mill manufacturing esparto papers, wood-free printings, writings, and similar grades has, during the past 5 years, converted its drier clothing wholly to all-synthetic felts on five machines. All drier sections are equipped with felt-drying cylinders, and the surface temperatures of the paper-drying cylinders vary from 80°F. at the wet end to 250°F. at the reel end. In the 5 years during which conversion to all-synthetic felts has been effected, machine speeds have been increased, modifications and renovations have necessarily been carried out, which admittedly introduce minor variables. The firm conclusion reported is that, because of the use of the all-synthetic felts, the total drier felt cost per ton of paper has been reduced by 50% and the steam consumption per ton of paper has decreased by 10%.

2. On one machine in a mill manufacturing bank notes and security papers, only all-synthetic drier felts are used. The sheet enters the dryers 70% moist and leaves the driers 4 to 5% moist, steam pressures in the cylinders being from 29 to 26 p.s.i. There are no felt driers or vapor removal facilities of any kind. Among the advantages which are claimed by the use of all-synthetic drier felts are (*1*) an increase of not less than 14% in speed without any increase in steam consumption, (2) total absence of stretch or shrinkage in both directions, whether the sheet is on or off the machine, (3) total absence of felt mark despite the high moisture content of the sheet entering the driers, (4) a more than threefold decrease in drier felt cost per ton of paper produced.

3. In a mill producing writings, banks, bonds, and a wide variety of fine papers, in the case of three machines the speed was limited by drying capacity when soft, four-layer cotton felts were used. On every section of all three machines, the cotton felt was replaced by a three-layer all-synthetic felt. Coupled with a slight reduction in steam consumption, the speeds of the machines have been increased 12% to 15%.

4. When using all-cotton felts on a machine producing fine printings and writings, decrease in drying efficiency with aging of the felts necessitated a progressive increase in the steam pressures in the cylinders. The drier part is now entirely converted to all-synthetic felts, throughout the service lives of which the steam pressures have been maintained at their initial low value.

In the case of machines on which only one or two sections of the drier part are clothed with all-synthetic felts, the other sections being clothed with synthetic-reinforced cotton felts, there have been numerous vague reports of "excellent drying" or "better drying." It is suspected that this refers, in many cases, to evenness of drying across the sheet rather than to economy in steam consumption. A few mills have reported that the installation of only one all-synthetic drier felt, out of a total of four or six clothed sections, has resulted in a saving in steam consumption, and one mill reported that the use of an all-synthetic felt on the last top section of the machine necessitated a reduction in steam pressure in the cylinders "due to the higher permeability of the felt." In this particular instance, the vapor permeability of the air-dry, unused all-synthetic felt was appreciably lower than that of the cotton felts previously used on this section. It is reasonable to assume that the greater drying efficiency was due to the relatively slight decrease in vapor permeability with increased moisture content in the case of the all-synthetic felt, compared with the rapid decrease in permeability with increasing moisture content in the case of the cotton felt. This is in accordance with the laboratory results recorded earlier.

An interesting illustration of the virtue of the rapid drying of a moist all-synthetic felt is afforded by a machine equipped with a hot air ventilating system. During the use of synthetic-reinforced cotton felts, increasing the temperature of the air blown through the drier section resulted in no over-all saving in steam consumption. When an all-synthetic felt of the same type and weight per unit area as the cotton felt was installed, an increase in the temperature of the ventilating air resulted in an appreciable over-all saving in steam consumption on the machine.

It seems probable that, in general, all-synthetic drier felts are being operated at higher tensions than those of the cotton or woolen felts which they have replaced. This is possible because of the greater dimensional stability of the all-synthetic felts, and in one instance (*5*), quantitative results have indicated that increased tension has resulted in improved steam economy. On the other hand, the felt referred to earlier is operating on the last top section of a newsprint machine at a tension which is only a fraction of that of the synthetic-reinforced cotton felts which preceded it, and, for an equal steam pressure, the sheet is leaving the cylinders at the same moisture content as before.

In general, it appears that experience in the use of all-synthetic drier felts confirms the forecasts based on laboratory results, although it is unfortunate that such little quantitative information is available on the subject of water removal efficiency.

THE EFFECT OF ALL-SYNTHETIC DRIER FELTS ON THE QUALITY OF THE SHEET

There are numerous reports concerning the influence of all-synthetic drier felts on the quality of the sheet, particularly in the production of fine and speciality papers. The most common report is that of improved evenness of drying across the sheet, resulting in a cockle-free paper at the reel. This indicates (1) absolute uniformity of tension across the operating all-synthetic felt, and (2) a capability, due either to high capillarity or high permeability, or both, of removing irregularities in the moisture content of the sheet entering the section clothed with the all-synthetic felt.

Striking visual evidence of (2) above is afforded by the experience of a paper mill producing writings, banks, and bonds. When using normal, soft, warp-faced cotton drier felts, the sheet was invariably rippled as it came out of the driers, a property which was, apparently, regarded as unfortunate but inevitable. The first all-synthetic felts to be operated were also warp-faced and a doubtful improvement in the quality of the sheet was reported. When, next, all-synthetic felts with a weft-flushed, broken sateen face were used, the sheet was free from wrinkles and ripples. This improvement was in no way related to felt mark, of which there had never been evidence, but appeared due solely to the fact that the face synthetic yarns, lying parallel to the across-machine direction, are capable, because of their extremely high capillarity, of rapidly removing existing irregularities in moisture content across the sheet.

This same property of the weft-faced all-synthetic felt has been reported in the case of the production of greaseproof and of lightweight tissues of 11 to 25 g. per sq. m.

A variation on the theme of cockle prevention is provided by the experience of a mill which produces high grade printings in which flatness of the sheet is of paramount importance. When woolen drier felts were used, nothing was found to prevent the middle of the felts becoming progressively slacker than the edges, due to uneven drying. Increasing tension in the felt merely tightened the edges, leaving the center slack, and this resulted in feathering spreading outwards from the center of the sheet, necessitating renewal of the woolen

drier felts. Conversion to all-synthetic drier felts has completely eliminated the trouble, and the sheet is free from feathers and cockles from the beginning to the end of the drier felts' life.

Second only to reports on evenness of drying are reports concerning improvements in the cleanliness of the sheet produced by the use of all-synthetic drier felts. These have emanated from paper mills which had previously used cotton felts, although the most spectacular reports have been in cases where all-synthetic felts have replaced woolen drier felts. Often, the working face of a cotton or woolen drier felt becomes discolored by scorching, and a proportion of the resultant dust must find its way on to the sheet. The fact that the degraded cellulose or protein dust is partially water soluble must result, in certain cases, in the sheet becoming permanently slightly discolored. The face of the all-synthetic felt, being more resistant to heat, retains its whiteness longer, and, even when partially degraded, the abrasion-resistance of the synthetic fibers is great enough to prevent their dispersion as dust.

Interesting illustrations are afforded in the cases of two paper mills which produce speciality papers. A mill manufacturing exclusively base paper for resin coating demands a high standard of cleanliness in the sheet. All-synthetic drier felts have given operating lives which, on an average, have been more than twice those of the woolen drier felts previously used. But the conviction has been expressed that, if the all-synthetic felt had a service life only half that of the woolen drier felt, the felt cost per ton of paper would still be less, because paper is no longer rejected as below the required standard of cleanliness. As evidence of this conviction, the mill, which has seven machines, has more than 40 all-synthetic drier felts in operation at any given time.

The second example is that of a paper mill manufacturing photographic-base paper exclusively. The hand-spliced seam of woolen drier felts, weighing 13 oz. per sq. ft., marked the sheet after only 3 months' service. When woolen drier felts specially woven endless were used, they were removed after a life which never exceeded 4 months because the scorched surface dirtied the sheet. An all-synthetic drier felt only half the weight of the woolen drier felt, and with a hand-spliced seam, has been in operation for 6 months, during which time the complete range of photographic-base paper has been made. The sheet is perfectly clean and is reported as being "better in every way."

On numerous paper machines, oil contamination of the edges of cotton felts becomes so acute that either the sheet must be run at a narrower deckle or the felt must be discarded before it has fulfilled its service life. The synthetic fibers absorb oil to a much less degree than does cotton, and, indeed, oil contamination of the edges of cotton felts has been minimized by the introduction of the synthetic-edge felt (*6*). A considerable number of paper mills have reported that the edges of all-synthetic felts run free from oil contamination and, therefore, the sheet can be produced at maximum deckle without oil staining.

A RECENT DEVELOPMENT

In the foregoing survey, all of the all-synthetic felts under review have had Dacron as their main constituent; indeed, every felt has had a minimum Dacron content of 75%, the residual component being nylon. The choice of Dacron as opposed to nylon was governed by three considerations: (1) the stress-strain relationship of the Dacron fiber is more conducive that that of the nylon fiber to the production of a dimensionally stable felt; (2) the acid resistance of Dacron is superior to that of nylon; (3) the heat resistance of Dacron is greatly superior to that of nylon. However, the vastly superior abrasion resistance and flexural endurance of nylon have always been attractive properties to the felt manufacturer, and, providing the defects of nylon could be overcome, its claim as a raw material in drier felt manufacture could no longer be denied.

With the advent of newer forms of nylon, the production of an all-nylon drier felt of dimensional stability at least equal to that of a felt composed wholly or predominantly of Dacron is possible, and has, indeed, been achieved. In spite of the high acid resistance of Dacron, it has been amply demonstrated that, under the conditions which appertain on certain drier sections, hydrolysis of the Dacron in all-synthetic felts is enhanced at low pH values, and, in fact, hydrolysis occurs in every instance, although generally this is sufficiently long delayed to ensure that the felt achieves an economic operating life. Hydrolysis of nylon requires more severe conditions than those encountered by an operating drier felt, and trials, both in the laboratory and on paper machines, have shown that, at stock pH values not lower than 4.0, degradation of nylon by very dilute acid conditions is less rapid than hydrolysis of Dacron under the moist, hot conditions.

The only remaining bar to the production of an all-nylon drier felt which, from a service-life point of view, would be as good under any machine conditions, and better under certain machine conditions, than one made predominantly from Dacron, was the inferior heat resistance of nylon. In the author's laboratories, a chemical process has been developed which renders nylon more heat resistant than Dacron.

Felts manufactured wholly or partly of this heat-resistant nylon are running trouble-free on a variety of paper and pulp-drying machines; it is, of course, too early to assess their performance. From a consideration of the properties of the heat-resistant nylon and of the felts produced from it, it is envisaged that these properties will be best exploited in felts which clothe (1) fast-running machines where a high degree of flexural endurance is required; (2) machines equipped with felt rolls of small diameter or with tortuous felt paths, where again flexural endurance will result in longer life; (3) drier sections notoriously severe on felts because of undue mechanical abrasion; and (4) wet drier sections at which rapid hydrolysis of Dacron has occurred.

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Improvements in the Determination of Holocellulose

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Improvements were made in the TAPPI Standard procedure for holocellulose determination. It was found that the time required for the determination was decreased by replacing the 95% ethanol solvent with dioxane. Five per cent monoethanolamine in dioxane proved to be a more effective chlorinated-lignin solvent than 95% ethanol containing a number of other organic bases.

It has long been desirable to isolate the total polysaccharide fraction from extractive-free wood in a substantially unchanged form. Two procedures have been in common use during the past several years. One method, TAPPI Standard T 9 m, employs repeated chlorination and extraction of the chlorinated wood sample with a hot solution of 3% monethanolamine in 95% ethanol and the other method employs a hot acetic acid-sodium chlorite solution (*1*). In the latter procedure some carbohydrate material is usually lost before all of the lignin is removed from the sample. For this reason, the procedure does not give quantitative yields and the product obtained is known as "chlorite holocellulose."

Experiences with the chlorination-basic ethanol procedure for the determination of holocellulose has shown that several deficiencies exist and it was for this reason that experimental work was performed to improve the method. First, it was believed that a solvent other than 95% ethanol might be more effective in extracting the chlorinated lignin and thus shorten the time required. Also, it is desirable to avoid the use of ethanol in many industrial laboratories where it is difficult to obtain nondenatured ethanol. Second, an organic base other than monoethanolamine might prove more effective. Third, it was hoped that the selection of a new amine or solvent might make the end point of complete lignin removal more readily observable. Excessive number of chlorinations and extraction treatments, particularly after the sample has been delignified, cause loss of polysaccharides.

EXPERIMENTAL

The wood samples used for the holocellulose determinations included both a softwood, Douglas-fir, and a hardwood, white oak. The wood was ground in a Wiley mill and then screened to separate 40 to 60-mesh and 60 to 80-mesh fractions. Following this, the wood meal was extracted in a Soxhlet extractor with an azeotropic mixture of ethanol and benzene. It was then exhaustively extracted with water at 100°C., room-dried, and stored in air-tight glass bottles.

Isolation and Solubilities of Chlorolignins

Gaseous chlorine may react with moist lignin by addition to double bonds, replacement of hydrogen, hydroxyl, or methoxyl groups, and oxidation through the formation of hypochlorous acid. Chlorolignins are unstable materials which readily give off hydrogen chloride so that in the ordinary chlorination of lignin a mixture of compounds will be present. These will have different solubilities. For this purpose, an attempt was made to isolate sufficient chlorinated lignin that its solubility in various common solvents might be conveniently determined. The literature reveals that many methods have been employed to prepare and isolate chlorolignins. In the present work, a sample of chlorinated lignin similar to that removed in the holocellulose procedure was desirable. Therefore, extractive-free wood was chlorinated and extracted with organic solvents with and without organic bases.

Twenty-five-gram samples of extractive-free 40 to 60-mesh Douglas-fir wood meal were placed in large fritted-glass funnels. The wood was moistened with cold water, the excess water removed by suction, and chlorine gas drawn through the samples by slight suction for 5 min. The chlorinated wood samples were then treated with four 50-ml. portions of the selected solvents shown in Table I. The resulting extracts were evaporated to about 50 ml. poured into 10 vol. of cold water, and acidified when basic. The precipitates were removed by centrifugation and were dried *in vacuo* at 55°C. The supernatant aqueous solutions were all dark-orange colored and may have contained substantial amounts of chlorolignin. No attempt was made to recover these water-soluble chlorolignins. Shorygina and Kolotova (*2*) found that chlorolignin was easily hydrolyzed in water or aqueous alkali solutions with a marked increase in hydroxyl groups and a corresponding increased solubility in water.

Table I. Yield and Appearance of Various Chlorolignin Preparations

Solvent	*Yield*	*Description*
3% Monoethanolamine in 95% ethanol	1.0 g.	Light orange powder
1,4-Dioxane	1.0 g.	Light orange powder
95% Ethanol	1.0 g.	Light orange powder
Methanol	1.0 g.	Light orange powder
2% KOH in 95% ethanol	0.5 g.	Dark brown powder

A similarly prepared sample of chlorinated wood meal extracted with methanol in a Soxhlet extractor gave a recovered yield of chlorolignin of only 1.1 g. The physical appearance of this product was the same as that of the other alcohol-extracted preparations.

In an attempt to obtain an increased recovery of chlorinated lignin, 25 g. of moist, chlorinated Douglas-fir meal was suspended in 250 ml. of 3% (v/v) monoethanolamine in 95% ethanol at 75°C. and agitated for 10 min. The wood meal was filtered and washed with 100 ml. of 95% ethanol. The extraction and washing were repeated once. Following this, the total extracts and washes were combined and evaporated *in vacuo* to about 50 ml. and poured into 10 vol. of cold water. The precipitate was collected by centrifugation and dried at 55°C. *in vacuo* to give a yield of 0.3 g. of a brown amor-

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Table II. Solubilities of the Chlorolignin Preparations in Various Solvents

Method of chlorolignin extraction	*Order of decreasing solubility* →					
	1	*2*	*3*	*4*	*5*	*6*
3% Monoethanolamine in 95% ethanol at 25°C.	D/M	D	E	M	I	A
1,4-Dioxane at 25°C.	D	D/M	M	E	I	A
95% Ethanol at 25°C.	Completely soluble in all					
Methanol, Soxhlet	M	D	D/M	E	I	A
3% Monoethanolamine in 95% ethanol at 75°C.	E	D/M	D	M	I	A
95% Ethanol saturated with NH_3 at 75°C.	D	D/M	D	M	I	A

D = 1,4-dioxane; M = methanol; E = 95% ethanol; I = isopropanol; A = acetone; D/M = 50% methanol in 1,4-dioxane.

phous powder. Identical results were obtained when a saturated solution of ammonia in 95% ethanol at the same temperature was used. The low yields probably resulted from the hydrolysis of the chlorolignins in the hot basic solutions to water soluble products.

The solubilities of the chlorolignin preparations in the selected solvents given in Table II were determined by accurately weighing 0.100-g. samples and mixing them with 3 ml. of each solvent at 25°C. The relative solubilities were estimated after centrifugation by a visual comparison of the color of the solution and the amount of residue remaining. Although the results of these experiments appeared somewhat indefinite, it was noted that dioxane and 50% methanol in dioxane were, in almost all cases, the best solvents.

When the above procedure was used to determine the effectiveness of several organic bases in dioxane, it was found that dioxane alone proved to be at least as effective as the basic solutions. Therefore, it was decided that the various bases would have to be evaluated by their actual use in a holocellulose procedure.

Holocellulose Determinations

An attempt was made to determine the value of the iced-water bath in TAPPI Standard T 9 m-54. It was found that without the water jacket the yields were somewhat lower and often varied by more than 1% from those samples cooled during chlorination. This is expected for the chlorination of wood is a highly exothermic reaction with considerable evolution of hydrochloric acid all of which are conducive to the hydrolysis of polysaccharides. The iced-water jacket was used in all subsequent holocellulose determinations.

The chlorination apparatus illustrated in Fig. 1 proved quite satisfactory. It is easily made and the jacket can be removed to facilitate working with the sample when it is not being chlorinated. No suction was necesssry during chlorination for the pressure of the chlorine gas cased it to pass through the wood sample.

The use of 60 to 80-mesh wood meal for the holocellulose determination in lieu of 40 to 60-mesh wood meal is known to decrease the number of chlorinations and extractions required to produce a lignin-free product. Therefore, 60 to 80-mesh wood meal was used in all of the subsequent work. The lignin content of the extracted Douglas-fir wood sample was found to be 27.84% by the 72% H_2SO_4 method. This indicated the holocellulose content should be approximately 72.16%. In Table III, it is seen that 4.5% lignin (76.72 − 72.16 = 4.56) remained in the wood meal after nine chlorinations and extractions with hot ethanolamine-ethanol solution performed in accordance with TAPPI Standard T 9 m.

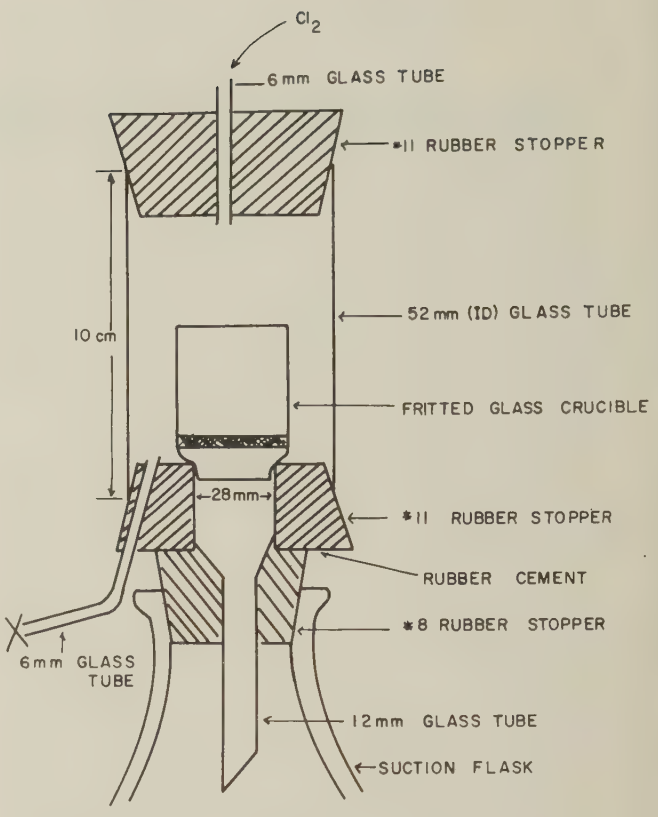

Fig. 1. Holocellulose apparatus

Inasmuch as the clarity of the end points for complete delignification obtainable with the other solvents and bases was not known, the delignification was stopped at a point several per cent above the actual holocellulose value with the standard ethanolamine-ethanol solvent. The procedure was repeated with new bases and solvents with the same number of chlorinations and extractions and under the same conditions. It was found that nine chlorinations and extractions gave a holocellulose product satisfactory for this purpose. The solvents used in lieu of 95% ethanol and the organic bases used in lieu of monoethanolamine are given in Table III. The volume to volume concentration of base in solvent was 3%.

The data in Table III show that a 3% solution of monoethanolamine in dioxane was superior to any

Table III. Conditions and Yields of Holocellulose Preparations

Solvent	*Base, 3%*	*Temperature of solution, °C.*	*Apparent % holocellulose*
95% Ethanol	Monoethanolamine	75	76.72
95% Ethanol	Morpholine	75	84.43
95% Ethanol	Ethylenediamine	75	82.36
95% Ethanol	Butylamine	75	78.98
95% Ethanol	Triethylamine	75	98.50
95% Ethanol	Triethanolamine	75	...[a]
Methanol	Monoethanolamine	65	83.57
Methanol-dioxane (1:1)	Monoethanolamine	65	78.80
Dioxane	Monoethanolamine	75	69.74
Dioxane	Morpholine	75	80.93

[a] Filtration impracticably slow.

other combinations of base and solvent. In subsequent work the effect of concentration of monoethanolamine in dioxane and temperature of the solvent was determined. First, the temperature of the solvent was varied from 25 to 95°C. keeping the concentration of monoethanolamine constant at 3%. Following this, the temperature of the solution was held constant at 50°C. while the concentration of the monoethanolamine was changed within the range from 1 to 7%. Nine chlorinations and extractions were performed in each case.

The results of these experiments, given in Figs. 2 and 3, show that the concentration of the monoethanolamine should be at least 3%, for below that content, a marked decrease in solvent ability occurred. Temperature of the solvent is seen to have an effect on the yield of holocellulose; the theoretical yield was reached at a temperature between 65 and 70°C. Below 50°C. some lignin remained in the holocellulose and at 75°C. some loss of carbohydrate occurred. The optimum temperature would be one that is high enough to remove the chlorolignin within a reasonable time, but low enough not to cause loss of carbohydrate or substituent groups from the holocellulose, such as acetyl groups. The temperature selected for further work was 50°C. and the concentration of the monoethanolamine in dioxane was increased from 3 to 5%.

The procedure adopted for the holocellulose determination on samples of Douglas-fir and white oak was as follows: The sample consisted of extractive-free, room-dried, 60 to 80-mesh wood meal whose moisture content was accurately known. Approximately 2 g. of the sample was weighed on an analytical balance into a tared fritted-glass crucible (C or M porosity). The crucible and contents were mounted on the apparatus shown in Fig. 1 and surrounded by iced water. About 20 ml. of cold water was added to the sample, and after stirring, the excess water was removed by moderate suction.

The upper stopper was placed firmly on the apparatus, and chlorine gas passed through the sample for 3 min. Following this, the sample was stirred with a glass stirring rod and then chlorinated for another 2 min. Next, the sample was covered with dioxane at room temperature, the mixture stirred, and the dioxane removed by suction.

The iced-water jacket was drained and removed and two successive portions of 5% monoethanolamine in

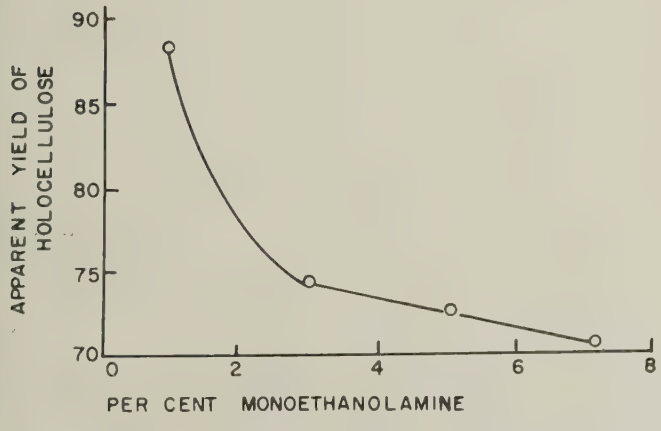

Fig. 2. Effect of concentration of the basic solution

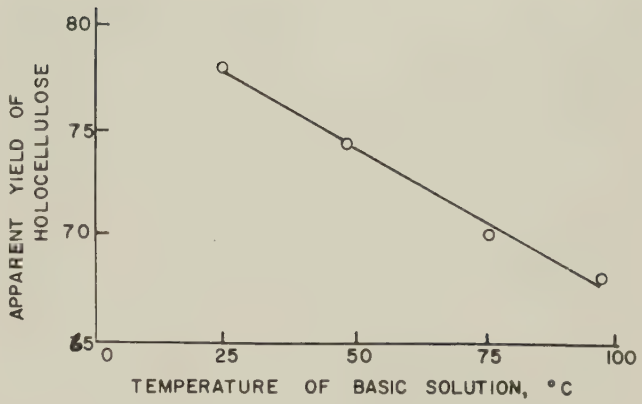

Fig. 3. Effect of temperature of the basic solution

dioxane at 50°C. were added and stirred thoroughly. Each portion was allowed to stand for 2 min. before removal by suction. The sample was next washed twice with dioxane at room temperature and twice with cold water.

The above procedure was repeated limiting the chlorinations to one uninterrupted 3-min. period for all subsequent treatments with the iced-water jacket in place. When the sample appeared white after chlorination, or when very little color change occurred upon addition of the basic dioxane solution, the sample was assumed to be substantially lignin free.

The holocellulose was then washed with dioxane until neutral and twice with diethyl ether. After room drying, the residue was oven-dried at 105°C. for 2.5 hr., cooled in a desiccator, and weighed in a stoppered weighing bottle. When analyses were performed on the holocellulose the latter was either dried *in vacuo* at 55°C. or room-dried with a suitable portion used for a moisture determination.

The average results of several analyses are shown in Table IV. The Douglas-fir holocellulose showed a loss of 0.2% pentosan and 0.07% acetyl groups, whereas the white oak showed a loss of 2.1% pentosan and 0.59% acetyl groups, all based on the weight of the moisture-free extractive-free wood. The total number of chlorinations and extractions necessary to prepare the holocellulose by the new procedure was nine for Douglas-fir wood and five for white oak; whereas, nine chlorinations and extractions using 3% ethanolamine in 95% ethanol left approximately 4.5% lignin in the product as determined with 72% H_2SO_4. Experience has shown that the last few per cent of the lignin is removed relatively slowly. The new procedure decreased the number of chlorinations and extractions by two or three necessary to give a lignin-free product.

Very often the last few treatments with ethanolamine-alcohol solvent are prolonged by slow filtration because of gelatinization or hydrolysis of the holocellulose.

Table IV. Analysis of the Extractive-Free Wood and of the Holocellulose

Material	*Per cent based on weight of oven-dry, extractive-free wood*			
	Yield	*Lignin*	*Pentosan*	*Acetyl*
Douglas-firwood	...	27.84	6.2	0.84
Douglas-fir holocellulose	72.41	0.02	6.0	0.77
White oak wood	...	19.22	24.1	2.39
White oak holocellulose	80.17	0.14	22.0	1.80

The removal of the lignin permits the carbohydrates with low D. P. to be dissolved. Slow filtration was not observed with the dioxane solvent.

The total amount of time required for a holocellulose determination of Douglas-fir wood averaged slightly less than 2 hr. excluding the time necessary for sample preparation and drying of the holocellulose. The time required by the present TAPPI Standard on the same sample averaged slightly over 3 hr.

The end-point color change with complete delignification did not appear to be much improved with dioxane. Because lignin gives color reactions with numerous organic and inorganic compounds, the addition of an appropriate indicator to either the solvent or to one of the wash solutions might improve this feature.

Effect of Impurities in the Reagents

Commercial grade 1,4-dioxane without purification and Eastman white label monoethanolamine, distilling between 168 and 171°C., were used in the experimental work. The addition of acidified potassium iodide-starch solution to the dioxane indicated a large amount of peroxides present.

The monoethanolamine-dioxane solution was quite turbid when first prepared and after standing over night, a yellow, oily, water-soluble substance precipitated leaving a clear, colorless supernatant solution. It is believed that the formation of the precipitate with ethanolamine was caused by the presence of the peroxides in the dioxane. A similar yellow substance develops in monoethanolamine after standing for several months or upon the addition of a 3% solution of H_2O_2.

The amount of monoethanolamine lost because of the impurities in the dioxane was determined. For this purpose, solutions of monoethanolamine in dioxane ranging from 1 to 5% were prepared and allowed to stand for 24 hr. At the end of this time the clear supernatant solution was titrated with 0.1 N H_2SO_4 to determine the content of monoethanolamine. It was found that the loss was about 0.9 ml. for each 100 ml. of dioxane, which represents a decrease of about 0.9% monoethanolamine in the basic solution.

After standing for several months the loss of ethanolamine in dioxane did not appear to increase appreciably, but the clear solution became dark yellow. The use of this solution did not appear to have an effect on the holocellulose determination, but because of its color, it is believed desirable to use the clear supernatant solution from a 24-hr. old monoethanolamine-dioxane mixture.

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Internal Pressure Distributions in Compressible Mats under Fluid Stress

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As a continuing study of the nature of fluid flow through compressible fibrous mats, the internal pressure drops were measured within fiber beds under fluid stress. Because of the cumulative effect of frictional drag forces acting on individual fibers, it has been hypothesized that compressible porous beds under the influence of an overall fluid pressure drop will have a porosity distribution from a maximum at the upstream mat face to a minimum at the downstream septum. This porosity distribution should determine the internal pressure drop distribution. Data are presented for mats of synthetic fibers and wood pulp fibers in which experimental values of internal pressure drops are compared with calculated values based on static measurements of mat compressibility. Good agreement was obtained by using empirical modification of the Kozeny-Carman equation to allow for large variations in the so-called Kozeny constant in high-porosity fiber beds.

In the general field of flow through porsou media, beds composed of fibrous materials have two unique features: (1) they form into mats of very high porosity, and (2) the fibers themselves are generally deformable under the action of either mechanical compacting pressure or fluid drag forces. These two characteristics lead to particular difficulties in attempts to gain understanding of the mechanism of flow through fiber beds.

The Kozeny-Carman approach to study of flow through porous media has had considerable success in systems composed of granular materials in which the individual particles are essentially noncompressible. The beds formed from such particles have limited and relatively narrow porosity ranges. Although this theory is confined to the streamline or viscous flow region, it has been empirically modified to correlate data in the transition and in the turbulent flow regimes. In the case of flow through compressible fiber beds, a simple force balance shows that the cumulative effect of frictional drag forces produces a change in mechanical compacting pressures acting on fibers throughout the bed. Because of the compressible nature of fibers, these different compacting pressures lead to a porosity distribution throughout the mat which varies from a maximum at the face, or upstream section, to a minimum value at the septum, or downstream part of the

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bed. Since porosity is related to the average pore size in the bed, and since pore size is one of the factors which determine the Reynolds number, the question naturally arises as to what particular value of Reynolds number could be used to characterize the flow regime in a bed of varying porosity. In addition, if a Kozeny-Carman-type analysis is to be applied, it is recognized that allowance should be made for large variation in the so-called Kozeny constant in the highly porous sections of fiber beds.

The experimental difficulties involved in attempting to directly measure the porosity distribution in compressible mats under fluid stress are obvious. Recently Hutto (*1*) reviewed some of the previous efforts made to directly measure the porosity distribution in filter cakes and concluded that these investigations had shown qualitatively that a maximum and minimum porosity existed at the upstream and downstream sections, respectively. Hutto reasoned that inherent errors in the previously used techniques were probably responsible for certain conflicting data as to what types of porosity distribution existed. Hutto used a technique of banding a filter cake formed from the filtration of a wood pulp slurry, and by photographing the banded cake while under fluid stress, was able to estimate the porosity distribution. Of course, the banded sections of the fiber bed were of finite thicknesses, and thus the estimated values of porosity were necessarily average values for the different cake sections.

To avoid the experimental difficulties involved in making direct measurements of porosity distribution, the approach taken in this study was to measure the pressure gradient in fibrous mats under fluid stress. Then, if the pressure gradient can be related to the mat porosity through Kozeny-Carman-type analysis, it should be possible to predict the pressure gradients under given fluid stress from experimentally measured values of mat compressibility. The accuracy of the expression relating pressure gradient and porosity may be checked by comparing the experimentally measured pressures with the predicted values.

EXPERIMENTAL

Method of Attack

Essentially, the experimental work consisted of three parts: (1) determination of the variation of Kozeny constant with porosity for fibers of regular and well-defined geometry and for given orientation conditions in the mat; (2) measurement of static fiber mat compressibility by determining the over-all mat density as a function of mechanical compacting pressure, and (3) determination of the pressure gradient through fiber mats under fluid stress. In all the experimental work water was used as the permeating fluid.

As discussed in previous papers (*2, 3, 4*), the Kozeny-Carman equation may be applied to analyze flow through compressible beds that are maintained at a uniform porosity. If the flow through the bed is streamline, the resistance of the mat, R, at a given porosity may be calculated from a form of Darcy's law,

$$R = \frac{A\ \Delta P}{\mu q W} \qquad (1)$$

where A is the area of flow, ΔP is the frictional pressure drop across the bed of fluid with viscosity, μ, and volumetric flow rate, q, and W is the basis weight of fibers in the bed. The Kozeny constant, k, may be calculated from experimental values of R if the fiber specific volume, v, and specific surface, S_v, are known and related to R by the Kozeny-Carman equation,

$$k = \frac{R\epsilon^3}{vS_v^2(1 - \epsilon)} \qquad (2)$$

where ϵ, the bed porosity, is calculated from knowledge of the bed density, c,

$$\epsilon = 1 - vc \qquad (3)$$

Recent books by Carman (*5*) and by Scheidegger (*6*) have summarized and discussed application of these equations to study of flow through porous media. The Kozeny constant, k, is characteristic of the pore shape and the tortuosity of flow in porous beds. For this reason it is dependent upon the orientation of particles in the bed. Many workers, notably Emersleben (*7*), Sullivan (*8*), Brown (*9*), Davies (*10*), and Lord (*11*), have shown that in high-porosity fiber beds the Kozeny constant increases rapidly with increasing porosity. To this author's knowledge, no specific data have been presented for flow of water through fiber beds with orientation typical of that of beds formed from dilute aqueous suspensions of fibers. In this type of formation, when the slurry suspension is dilute enough to prevent fiber flocculation, fibers are deposited with their axes normal to flow. The orientation in the x-y plane normal to flow, is perfectly random and there are no fibers oriented in the z-direction, parallel to flow. In this study, all the fiber beds were carefully formed in a manner to give this type of orientation. After formation, the beds were maintained at a uniform porosity by means of a permeable piston.

To obtain precise calculated values of Kozeny constant, k, it is necessary that accurate determinations of fiber specific surface and specific volume be made. For this reason, fibers with cylindrical shape, nonporous and essentially nonswelling in water, were used for this part of the study. Nylon and glass fibers with as nearly uniform diameters as possible were chosen. Fiber specific surfaces were based on microscopic measurements, and specific volumes were determined pycnometrically.

In the second part of the experimental work, fiber bed compressibilities were measured using a previously discussed technique (*2, 4*). Essentially, the method

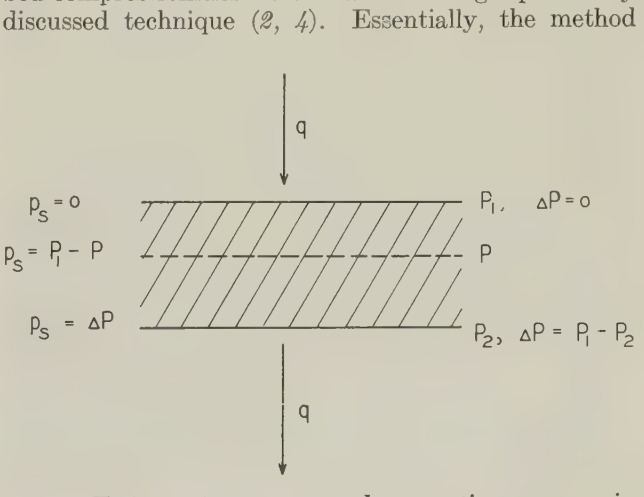

Fig. 1. Hydrostatic pressures and compacting pressures in a porous bed

consists of applying a static load to a permeable piston placed on the mat face. Care is taken to avoid viscoelastic and hysteresis effects, and the mat density, c, at a given compacting pressure, p_s, is calculated from thickness measurements. The data are correlated using the empirical compressibility function,

$$c = M\, p_s^N \qquad (4)$$

where M and N are constants.

Up to this point, flow measurements and compressibility data were taken for beds at uniform densities (and hence uniform porosities). The third part of the experimental work was carried out on fiber beds compacted by fluid stress. The relationship between mechanical compacting pressure and fluid pressure drop has been discussed previously (*2*) and is well explained in a recent text (*12*). A clear picture of the nature of fluid compaction in flow through a compressible mat may be seen by considering the situation shown in Fig. 1. A compressible bed which is shown as flow, at volumetric rate, q, occurs with an over-all frictional pressure drop of ΔP. Hydrostatic liquid pressures are indicated by P and mechanical compacting pressures (stress pressures) by p_s. Consider a unit area of mat normal to the flow and neglect both fiber weight and change of hydrostatic pressure with elevation. The force, P_1, acting on the total face of the mat must be balanced by a force acting on any parallel section in the mat such as indicated by the dotted line in Fig. 1. This force acting on the parallel section can be considered as composed of a force, P, acting on the voids, i.e., the liquid and a force, p_s, acting on the solid, i.e., fibers. Therefore,

$$P_1 = p_s + P \qquad (5)$$

Thus, the boundary conditions shown in Fig. 1 are obtained for the mechanical compacting pressure, p_s, at the upstream and downstream sections. Furthermore, differentiating equation (5) gives

$$dp_s = -dP = d(\Delta P) \qquad (6)$$

Thus, the rate of change of mechanical compacting pressure acting on the particles in the bed is equivalent to the rate of change of fluid pressure drop. At any point in the bed, the mechanical compacting pressure acting on the fibers at that point is the result of the frictional pressure drop past those individual fibers plus the cumulative frictional pressure drop due to all the fibers behind (upstream).

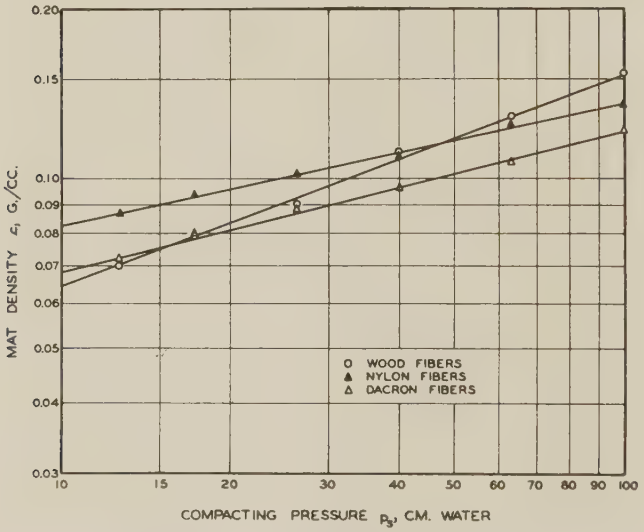

Fig. 2. Wet fiber mat compressibilities under static load

In the third part of the experimental work, it was desired to measure the internal fluid pressure of compressible fiber mats under fluid stress. At one extreme, an incompressible bed would have a linear rate of change of pressure with mat thickness. A compressible bed, however, would have a nonlinear pressure distribution, the extent of nonlinearity increasing with greater mat compressibility. Three fiber systems of different compressibility characteristics were studied in this part of the work: (1) nylon, (2) Dacron, and (3) bleached sulphite wood pulp.

Kozeny-Carman theory can be applied at a point in a compressible bed. Using equations (1) and (2) and relating mat density, c, at that point to thickness, L, by $c = dW/dL$ gives

$$\frac{d(\Delta P)}{dL} = \left[\frac{\mu q S_v^2}{A}\right]\left[\frac{k(1-\epsilon)^2}{\epsilon^3}\right] \qquad (7)$$

This equation can be used to predict the pressure gradient, $d(\Delta P)/dL$, if the relationship between Kozeny constant, k, and porosity, ϵ, is known, and when the mat compressibility, i.e., relationship between pressure drop and porosity, is known. The objective of the first two parts of the experimental investigation was to obtain these data for use in equation (7). Then the experimental values of pressure gradient obtained in the third part of the work may be compared to the predicted values.

Fiber Properties

The specific volumes of nylon, Dacron, and glass fibers in water were measured by a pycnometric technique, taking care to eliminate entrained air. The desired specific volume is the so-called hydrodynamic specific volume, or volume denied to water flow per unit mass of dry fiber. The above fibers are nonporous, but nylon and Dacron swell slightly in water. Microscopic measurements indicated the volume swelling of nylon in water was about 3%. Therefore, the pycnometric values for nylon were corrected for this slight swelling. The volume swelling of Dacron was less than the precision of the pycnometric determinations and therefore was neglected. Wood pulp fibers are both highly porous and swollen in water. Therefore, it was necessary to determine the hydrodynamic specific volume of this material indirectly in a manner which will be discussed later. The experimental values of specific volumes are listed in Table I. The results for nylon, Dacron, and glass fibers agreed with manufacturer's data.

Nylon, Dacron, and glass fibers have cylindrical shapes, and for these materials, the specific surface, S_v, defined as external area per unit volume of fiber, is given by $S_v = 4/D_{av}$, where D_{av} is the surface-weighted average fiber diameter. This average diameter was calculated from microscopic measurements of about 300 fibers of each sample. The close agreement of the arithmetic average and surface-weighted average diameters shown in Table I is indicative of the relatively narrow size range of these fibers. The surface-weighted average diameter for nylon and Dacron agreed well with those calculated from the manufacturer's specification of 3-denier. The bleached sulphite wood pulp was un-

Table I. Fiber Properties

Fiber	Fiber length, mm.		Fiber diameter, mm.		Specific volume,	Specific surface	Compressibility, c.g.s. units	
	Arithmetic average[a]	Weighted average[b]	Arithmetic average[a]	Weighted average[b]	v, cc./g.	S_v, sq. cm./cc.	M	N
Nylon	5.57	6.47	19.2	19.5	0.904	2,050	0.0104	0.225
Dacron	5.03	5.30	16.9	17.1	0.725	2,340	0.0066	0.254
Glass	0.78	0.94	16.4	16.5	0.384	2,420	...	...
Wood	1.60	2.56	...	...	2.12	3,080	0.00203	0.376

[a] Arithmetic average = $\Sigma fx/100$ where f = frequency and x = fiber property.
[b] Surface-weighted average = $\Sigma fx^2/\Sigma fx$.

beaten and had fines removed in a Bauer-McNett classifier. The pulp surface area was calculated from hydrodynamic measurements to be discussed later.

The mats for compressibility measurements were formed from constant-rate filtrations of dilute slurries of about 0.01% consistency in a previously discussed apparatus (*13*). The final pressure drop across the mat was always less than the initial compacting pressure used on the permeable piston for determining mat density as a function of compacting pressure. This procedure is necessary to avoid hysteresis effects. Measurements were made over a pressure range of about 10 to 100 g. per sq. cm. and the data are correlated in Fig. 2 according to equation (4). The values for compressibility constants M and N are given in Table I. Measurements made at higher pressures have shown that the same values of the compressibility constants hold up to at least several hundred pounds per square inch. However, the simple function given in equation (4) cannot be accurately extrapolated to pressures appreciably lower than 10 g. per sq. cm. since a fiber mat has a finite density at zero compacting pressure (*2*).

Permeability Measurements

A photograph of the apparatus used to measure the flow rate and pressure drop across fiber mats at fixed porosities is shown in Fig. 3. Thick mats were formed from constant-pressure filtrations, and then were held at uniform porosities by means of a hydraulically loaded permeable piston. Care was taken that the pressure drop across the mat during flow measurements never exceeded about 1% of the pressure on the piston. Pressure drops in excess of this value cause mat deformation that leads to a nonlinear relationship between pressure drop and flow rate. Flow measurements were made only in the streamline region. Equation (1) was used to calculate mat resistance, R, at a given porosity by determining the slope of the pressure drop, ΔP, and flow rate, q, relationship. Data were obtained for nylon and glass fiber mats over a porosity range from 0.68 to 0.96.

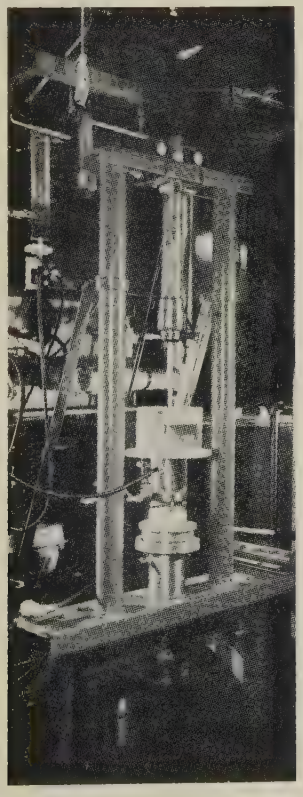

Fig. 3. Permeability apparatus for uniformly compacted mats

Pressure Distribution Measurements

A special filtration tube was used to measure the internal fluid pressures in thick mats under fluid stress. A picture of this tube in shown in Fig. 4 and a schematic diagram of the flow apparatus is given in Fig. 5. The pressure taps were $^1/_{16}$ in. diam. in a $3^1/_8$ in. diam. filtration tube. Fourteen of these taps were staggered around the circumference of the tube. The pressure taps were connected to a pressure manifold and pressure drops were measured with a two-fluid differential manometer. Mat thicknesses were measured with a cathetometer. Data were taken for nylon, Dacron, and bleached sulphite wood pulp beds formed from constant-rate filtrations of dilute slurries at about 0.01% consistencies. One complete set of internal pressure-drop measurements were made at a given

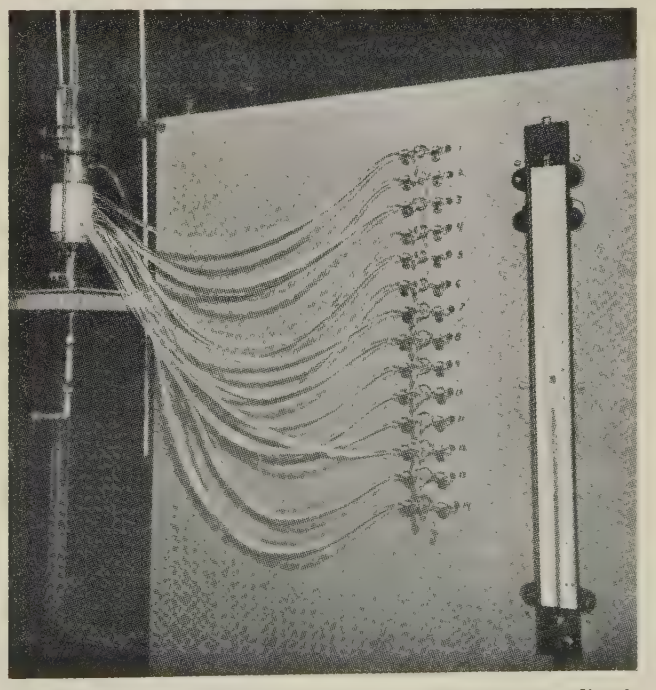

Fig. 4. Flow tube for measuring internal pressure distributions in fiber mats under fluid stress

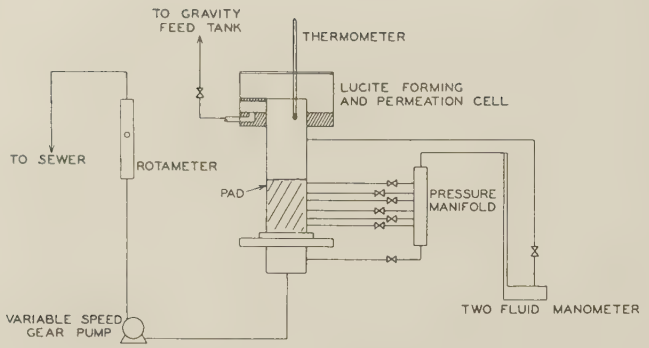

Fig. 5. Apparatus for measuring internal pressure distributions

over-all pressure drop (fixed flow rate), and then the flow rate was increased to make other sets of measurements. Data were always taken with increasing flow rate to avoid hysteresis effects.

RESULTS AND DISCUSSION

Variation of Kozeny Constant

Values of mat resistance, R, at given porosities were used together with fiber properties from Table I to calculate the Kozeny constant, k, from equation (2). The calculated values are shown in Fig. 6 for nylon and glass fiber beds with all fibers oriented randomly in the x-y plane normal to flow. The data are compared to Brown's (*9*) results from air permeability measurements on glass fiber beds with fibers oriented perpendicular to flow. Because of Brown's method of forming beds, he did not have a truly random orientation in the x-y plane. However, the agreement of the data in the two studies appears reasonable. The value of Kozeny constant of about 5.5 in the porosity range, 0.70–0.80, agrees with the average result obtained by Fowler and Hertel (*14*) in air permeability studies of similarly oriented textile fibers.

To obtain low-porosity nylon fiber beds, it was

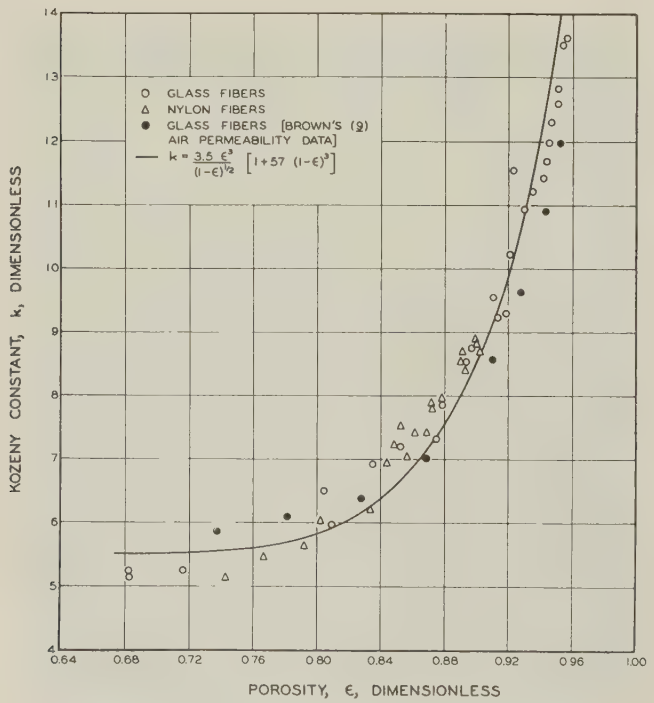

Fig. 6. Variation of Kozeny constant with porosity

necessary to use relatively high compacting pressures of several hundred pounds per square inch. There was some question that at these high pressures the nylon fibers might be so deformed that they would no longer be in point contact with each other. If this were the case, the effective value of specific surface, S_v, would be less than that based on the microscopic measurements, with the result that the calculated k values from equation (2) would be in error. To check this possibility, glass fiber beds were also formed in the same porosity range. Since glass fibers themselves are nondeformable, it can be assumed that they are in point contact at high compacting loads. The general agreement between the data for glass and nylon fibers indicates that point contact was maintained for both fibers. Lower porosities could not be studied with the glass fiber mats since the necessary compacting pressure was great enough to fracture and splinter the fibers. Microscopic examination of the glass fiber beds used to obtain the data in Fig. 6 showed that some fibers were breaking and becoming shorter but no fibers were being crushed to finer diameters.

Davies (*10*) correlated air permeability measurements on filters formed from numerous fibrous materials by using the empirical function,

$$k = a \frac{\epsilon^3}{(1 - \epsilon)^{1/2}} [1 + b(1 - \epsilon)^3]. \qquad (8)$$

Davies' values for constants a and b were 4.0 and 56, respectively. This function proposed by Davies was fitted to the data in Fig. 6 and the curve shown there has values for constants a and b of 3.5 and 57, respectively. The differences in these values and those found by Davies are probably due mainly to orientation differences since some of Davies' fibers were probably oriented in the z-direction.

Emersleben (*7*) solved the Navier-Stokes equation for uniform cylinders in a square array with flow parallel to the cylinders and showed that the Kozeny constant increases with increasing porosity. Recently, Shearer (*15*) applied the Navier-Stokes equation to flow normal to cylinders arranged in a hexagonal pattern and used an electrical analog method to solve the resulting biharmonic differential equation. Although the values of Kozeny constant obtained from Shearer's analysis were about four times larger than experimentally measured values, they showed about the same percentage variation with porosity. Shearer concluded that the variation of Kozeny constant cannot be explained simply by assuming that the pore size or shape distributions change with porosity. Scheidegger (*6*) has criticized the simple capillary model upon which the Kozeny-Carman theory is based and has proposed a statistical analysis. However, this approach is not sufficiently advanced whereby useful results can be obtained with direct application to problems of engineering interest. The results obtained in this study and by others which show that the Kozeny constant is not a true constant indicate the flow mechanism upon which the Kozeny-Carman equation is based is oversimplified for flow through fiber beds of high porosity. However, even if the mechanism is nothing but convenient fiction, the continued use of the theory can be justified by the fact that its relatively simple analysis leads to intelligible results which can be related to experimental observations.

Assuming, as the data in Fig. 6 indicate, that equation (8) represents the variation of Kozeny constant with porosity, substituting for k in equation (4) gives

$$\frac{d(\Delta P)}{dL} = \left[\frac{\mu q S_v^2 a}{A}\right](1 - \epsilon)^{3/2}[1 + b(1 - \epsilon)^3] \qquad (9)$$

This equation should be applicable to flow through cylindrically shaped fibers oriented randomly in the x-y plane perpendicular to flow. The empirical constants, a and b, have values of 3.5 and 57, respectively, as determined for nylon and glass fibers.

Internal Pressure Distributions

A series of measurements was made for internal pressure distributions of nylon and Dacron fiber mats under several over-all pressure drops. To obtain a general method for expressing the experimental data, a dimensionless form of graphical representation was used in which the relative pressure drop was expressed as a function of the relative mat thickness. Thus, if ΔP is the over-all pressure drop across a mat of total thickness, L, the pressure drop, Δp, at any point in the mat of thickness l is expressed as relative pressure drop, $\Delta p/\Delta P$, at relative thickness l/L. Experimental data for runs made at two different over-all pressure drops are shown in Figs. 7 and 8 for nylon and Dacron fiber beds, respectively. The results show that the pressure-drop distributions in these cases are independent of the over-all pressure drop. The pressure-drop gradient (rate of change of relative pressure drop with respect to relative thickness) increases with increasing mat thickness and is greatest at the downstream, or septum, section of the mat.

These synthetic fiber beds have very high porosities; the minimum porosities are indicated in Figs. 6 and 7 and are not less than 0.89. The maximum porosities exist at the mat face, or upstream section, and are approaching unity. The exact value of porosity at the mat face is not known but is dependent upon the frictional drag forces past the individual fibers which form a hypothetical layer, one-fiber-diameter thick. An estimate of this porosity was obtained by allowing

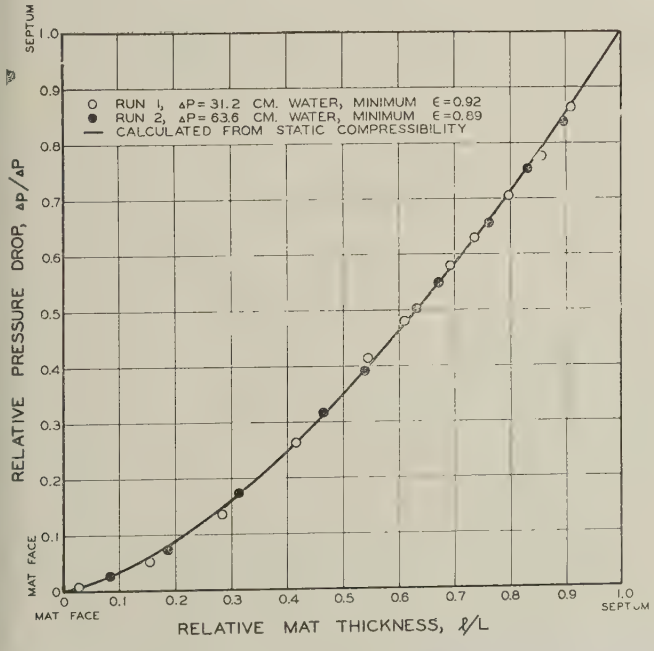
SEPTUM
RUN 1, ΔP = 31.2 CM. WATER, MINIMUM ϵ = 0.92
RUN 2, ΔP = 63.6 CM. WATER, MINIMUM ϵ = 0.89
CALCULATED FROM STATIC COMPRESSIBILITY
RELATIVE PRESSURE DROP, Δp/ΔP
MAT FACE
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
MAT FACE
SEPTUM
RELATIVE MAT THICKNESS, l/L

Fig. 7. Relative-pressure-drop gradient for nylon fibers

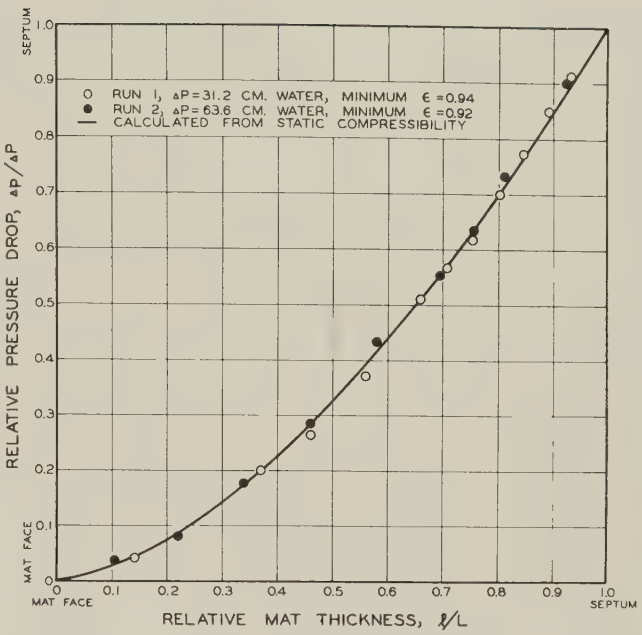
SEPTUM
RUN 1, ΔP = 31.2 CM. WATER, MINIMUM ϵ = 0.94
RUN 2, ΔP = 63.6 CM. WATER, MINIMUM ϵ = 0.92
CALCULATED FROM STATIC COMPRESSIBILITY
RELATIVE PRESSURE DROP, Δp/ΔP
MAT FACE
0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
MAT FACE
SEPTUM
RELATIVE MAT THICKNESS, l/L

Fig. 8. Relative-pressure-drop gradient for Dacron fibers

fiber beds to form by free-settling from suspensions and measuring the thickness of mats so formed. This type of mat is compacted by the weight of the fibers in water and was found to have consistencies of roughly 0.3%. This corresponds to a porosity of about 0.997 for nylon and Dacron.

At porosities of 0.90 and greater, the factor $[1 + 57\ (1 - \epsilon)^3]$ in equation (9) is approximately equal to unity, and the equation may be simplified to

$$\frac{d(\Delta P)}{dL} = \left[\frac{\mu q S_v^2 a}{A}\right]\left[(1 - \epsilon)^{3/2}\right] \qquad (10)$$

Then, by expressing the solid fraction $(1 - \epsilon)$ in terms of compacting pressure from equations (3 and 4), equation (10) can be integrated to give the theoretical variation of relative pressure drop, $\Delta p/\Delta P$, with relative length, l/L. Assuming the lower integration limits to be approximated by mat density equal to zero compacting pressure, the following relationship is obtained:

$$\frac{\Delta p}{\Delta P} = \left[\frac{l}{L}\right]^{1/(1 - 3/2\,N)} \qquad (11)$$

This result indicates that the relative pressure drop in fiber mats under fluid stress (with porosities not less than 0.9) should depend *only* on the mat compressibility as expressed by the empirical compressibility constant, N, from equation (4). It also shows, as the experimental results have already indicated, that the relative pressure drop in high-porosity mats should be independent of the over-all pressure drop.

Equation (11) and values of N from Table I were used to calculate the theoretical variation of relative pressure drop with relative length. The results of these calculations are shown as the curves drawn in Figs. 7 and 8. The curves fit the experimental data points very well, and it may be concluded that the function in equation (8) is correct for high-porosity fiber beds. Conversely, it may be concluded that equation (10) satisfactorily relates the pressure gradient to the porosity distribution in high-porosity mats.

It was not possible to study synthetic fiber mats under fluid stress at porosities much lower than those shown in Figs. 7 and 8 since the higher over-all pressure drops necessary to achieve lower porosities correspond to flow rates where the inertial resistance becomes significant in comparison to the viscous resistance. This flow regime where turbulent flow begins to develop is presently being studied. The equations presented here apply only for viscous flow.

Wood pulp fibers form beds of lower porosities than synthetic fibers because of their greater specific volumes (swollen in water) and greater compressibility (Fig. 2). However, because of their porous nature, swelling in water, and irregular shape, the fiber properties of specific volume, v, and specific surface, S_v, cannot be determined independently of hydrodynamic measurements. For these reasons, the Kozeny constant cannot be calculated for this type of fiber. It might be assumed, however, that the Kozeny-constant values determined for cylindrical fibers would apply to wood pulp fibers since they have roughly cylindrical and elliptical cross-sections. Figure 9 shows some typical cross sections of the bleached sulphite wood pulp fibers used in this study.

Assuming, then, that equation (9) can be applied to mats formed from wood pulp fibers, it may be rearranged in the following form:

$$\left[\frac{\mathrm{d}(\Delta P)}{c^{3/2}\,\mathrm{d}L}\right] = \left[\frac{\mu q S_v^2\, a\, v^{3/2}}{A}\right][1 + bv^3c^3] \qquad (12)$$

If the left-hand member of equation (12) is plotted as a function of the cube of mat density (c^3), the slope and intercept of the resulting linear relationship could be used to determine v and S_v.

The pressure-drop and mat-thickness relationship was measured for a thick mat of wood pulp fibers and is shown in Fig. 10. The pressure-drop gradient, $\mathrm{d}(\Delta P)/\mathrm{d}L$, was then determined at pressure drops equivalent to mat density, c, (from Fig. 2) by measuring slopes in Fig. 10. The rectified form of equation (9) as represented by equation (12) was calculated from the data and is shown in Fig. 11. Although the precision of the data is limited, the relationship appears linear, and the values of specific volume, v, and specific surface, S_v, determined from the slope and intercept are given in Table I.

Fig. 9. Softwood pulp fiber cross sections

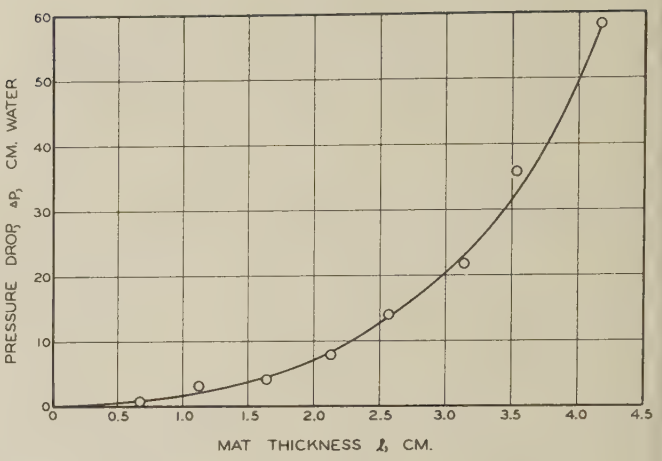

Fig. 10. Wood pulp mat pressure gradient

The relative-pressure-drop and relative-thickness experimental data for these same wood pulp fibers are shown in Fig. 12 for two values of over-all pressure drop. The deviation of the relative-pressure-drop gradient from the linearity characteristic of an incompressible medium is greater than for the synthetic fibers (Figs. 7 and 8) because of the greater fiber compressibility. The data show that now the relative pressure drop also depends upon the over-all pressure drop, larger over-all pressure drops increasing the deviation from linearity.

The lower porosity range shown in Fig. 12 for wood pulp requires that the right-hand factor in equation (9) be included in evaluating the theoretical relative-pressure-drop gradient. In this case:

$$\frac{\int_0^{\Delta p} \dfrac{\mathrm{d}(\Delta p)}{c^{3/2}(1 + bv^3c^3)}}{\int_0^{\Delta p} \dfrac{\mathrm{d}(\Delta p)}{c^{3/2}(1 + bv^3c^3)}} = \frac{l}{L} \qquad (13)$$

Unfortunately, equation (13) cannot be integrated by formula. However, the compressibility data from Fig. 2 and specific volume given in Table I were used to integrate equation (13) graphically. The resulting relationships for relative pressure drop as a function of relative length are shown in Fig. 12. The theoretical curves fit the experimental data reasonably well and show that, as equation (13) predicts, a different relation-

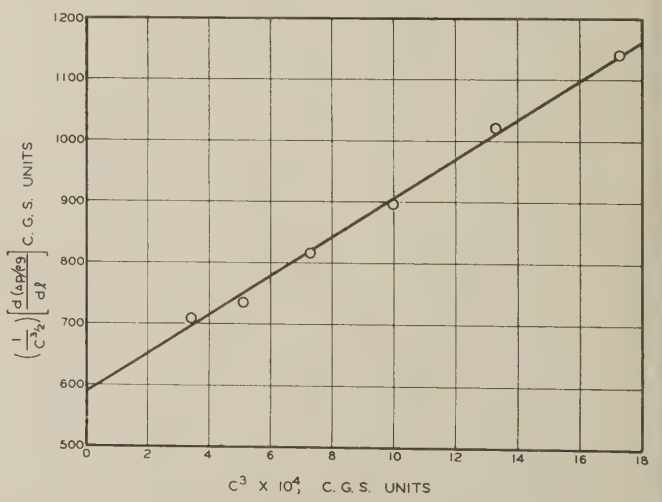

Fig. 11. Rectified Kozeny-Carman equation relationship from pressure gradient of wood pulp mat

ship is obtained for different over-all pressure drops. Thus, it may be concluded that the relative-pressure-drop gradient over a porosity range covering values less than 0.90 depends upon mat compressibility, fiber specific volume, and over-all pressure drop. It is also concluded that equation (10) satisfactorily represents the variation of pressure drop with porosity in beds of wood pulp fibers through which the flow is streamline.

The data for relative-pressure-drop distributions may be used together with the compressibility data to calculate the porosity distribution in fiber beds under fluid stress. Examples are shown in Fig. 13 for nylon, Dacron, and wood pulp. The dotted parts of the curve are based on the extrapolated compressibility function at pressures less than those covered in the experimental data (less than 10 g. per sq. cm.). For this reason, the values near the mat face, where the actual porosity is slightly less than unity, may be somewhat in error. Nylon and Dacron, in a high-porosity range, show a rapid decrease in porosity near the mat face, then a nearly linear decrease in porosity with increasing relative thickness. Wood pulp, in a lower porosity range, has a nearly linear decrease in porosity, with an increasing rate of change near the septum. Contrary to Hutto's (*1*) opinion, there is no reason why the porosity distribution curves for different materials should have similar shapes. The nature of the porosity distribution is dependent upon the bed compressibility characteristics, the hydrodynamic specific volume of material in the bed, and the over-all pressure drop across the bed.

Application to Filtration Theory

Previous papers (*3*, *4*, *13*) have discussed calculation of the important fiber properties of specific volume and specific surface from constant-rate filtrations of wood pulp fibers. The equations used were based on a form of equation (7) and neglected the variation of Kozeny constant with porosity. Since these filtrations

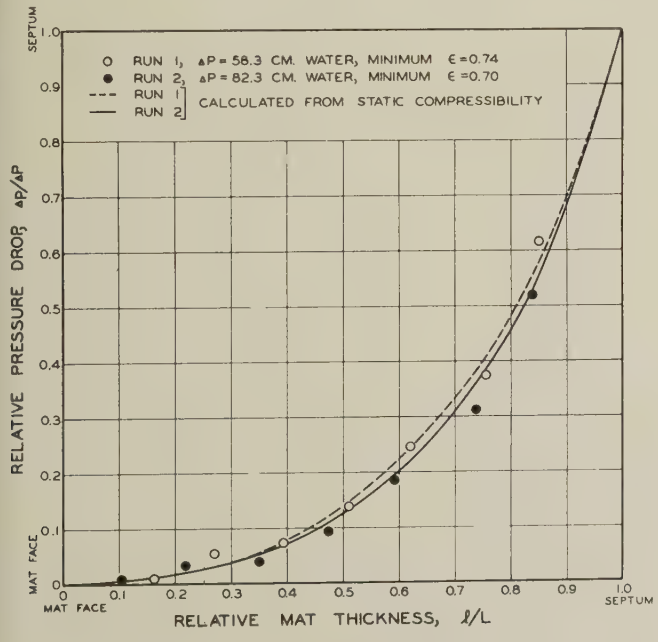
RUN 1, ΔP = 58.3 CM. WATER, MINIMUM ε = 0.74
RUN 2, ΔP = 82.3 CM. WATER, MINIMUM ε = 0.70
RUN 1
RUN 2
CALCULATED FROM STATIC COMPRESSIBILITY
RELATIVE PRESSURE DROP, Δp/ΔP
RELATIVE MAT THICKNESS, ℓ/L
MAT FACE
SEPTUM

Fig. 12. Relative-pressure-drop gradient for wood pulp fiber

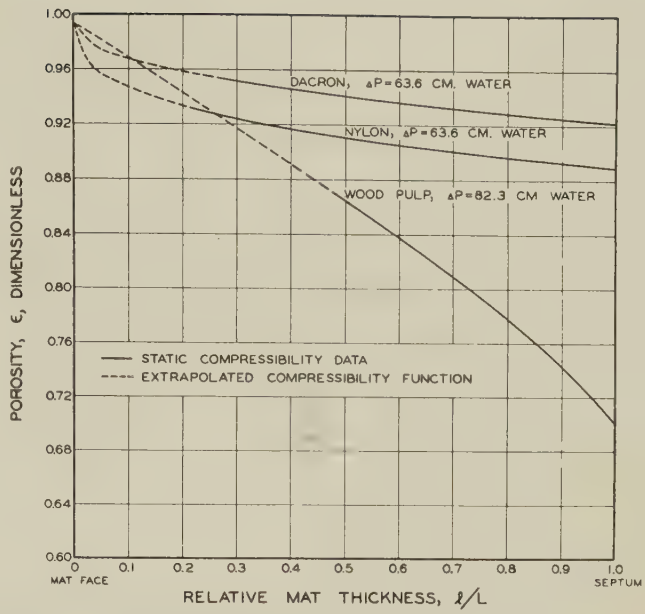

Fig. 13. Porosity distributions in fiber mats

are made with dilute fiber suspensions free from flocculation effects, the same type of fiber orientation in the filter mat is obtained as in this study. Therefore, the empirical equation relating Kozeny constant and porosity as combined in equation (9) should be more accurate than that which neglects the variation.

When equation (9) is applied to the filter mat formed in a constant-rate filtration, the resulting equation may be arranged to give

$$\left[\frac{d(\Delta P)}{c^{1/2}\, d\theta}\right] = \left[\frac{aS_w^2}{Bv^{1/2}}\right][1 + bv^3c^3] \qquad (14)$$

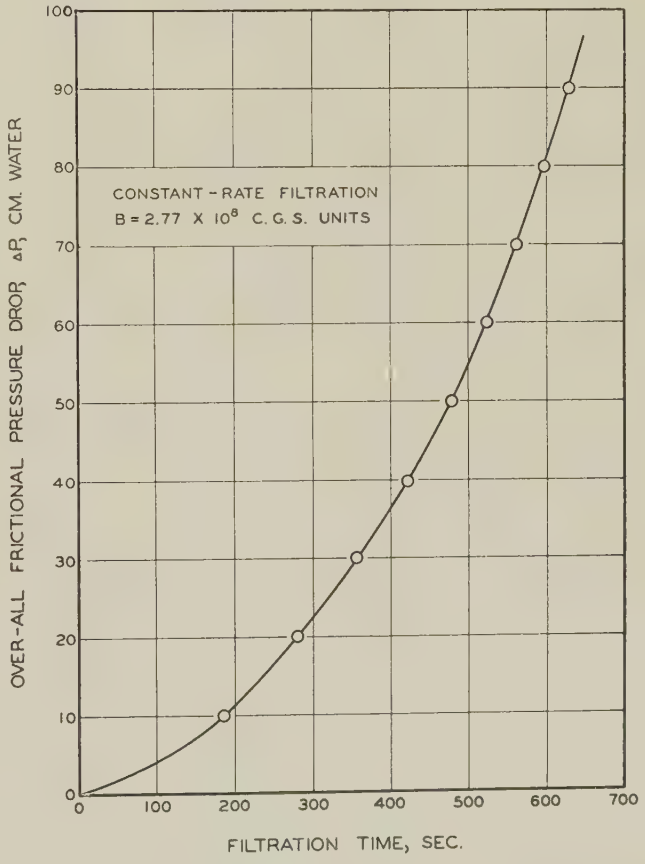

Fig. 14. Wood pulp constant-rate filtration data

Table II. Comparison of Calculated Values of Specific Surface and Specific Volume for Wood Pulp

Method	*Specific surface, S_w, sq. cm./g.*	*Specific volume, v, cc./g.*
Pressure gradient[a] (Kozeny constant treated as a variable)	6500	2.12
Constant-rate filtration[b] (Kozeny constant treated as a variable)	6250	2.02
Constant-rate filtration[c] (Kozeny constant treated as a constant)	6900	1.65

[a] Equation (12).
[b] Equation (14).
[c] Equation (15).

where $B = A^2/\mu C q^2$, a filtration constant. The previously used relationship neglects variation in Kozeny constant and assumes it equals 5.55. Its rectified form is

$$\left[\frac{c\,d\theta}{d(\Delta P)}\right]^{1/3} = \left[\frac{B}{kS_w^2}\right]^{1/3}[1 - vc] \qquad (15)$$

In these two equations, $d(\Delta P)/d\theta$ is the rate of change of over-all pressure drop with respect to time of filtration and S_w is the fiber specific surface defined on a mass basis ($S_w = v\,S_v$).

In Fig. 14, the pressure drop-time data are given for a constant-rate filtration of the classified wood pulp. Calculated values from these data according to equations (14) and (15) are shown in Fig. 15, and the results for values of specific surface and specific volume are compared in Table II. The two methods give significantly different values for these fiber properties. Equation (14), which accounts for variation in Kozeny constant, is more reliable. The apparent agreement of equation (15) may be due in part to its relative insensitivity, since the method of rectification extracts the cube root of experimental data for rate of change of pressure. Over a relatively small range of porosity, the relationship may appear to be linear. This relative insensitivity may be seen in Fig. 13 where the coordinates were purposely chosen to have the same scale factors for both equations. Equation (15) gives results of the right order of magnitude because in the region of high porosity where the Kozeny-constant variation is large, there is relatively little pressure drop. For example, Fig. 12 shows that at 0.5 relative thickness, only about 0.1 of the over-all pressure drop occurs. In regions of lower porosity, Fig. 6 shows that the Kozeny constant is reasonably constant at the assumed value of about 5.5.

The constant-rate filtration technique is a much easier tool for determining specific surface and specific volume than is the measurement of internal-pressure gradients. In addition, the precision of the original data is better in constant-rate filtrations as may be seen by comparing Figs. 10 and 14. For this reason, the calculated results from constant-rate filtrations are considered more accurate than the values previously calculated from internal-pressure gradients and compared in Table II.

SUMMARY

The variation of Kozeny constant with porosity was determined for cylindrical fibers oriented randomly in the x-y plane perpendicular to flow of water. This variation was described by an empirical relationship which was used to modify the Kozeny-Carman porosity function. The resulting equation was used to predict the internal pressure-drop gradients in fiber mats of nylon, Dacron, and wood pulp from knowledge of fiber mat compressibility characteristics. Good agreement between the predicted gradients and experimental observations supported the validity of the flow equations.

The flow equations were then used to determine the porosity distributions in fiber mats under fluid stress. This type of information is necessary in the characterization of transition and turbulent-flow regimes in fiber mats.

Finally, it was shown that fiber properties of specific surface and specific volume were in reasonable agreement when calculated from either constant-rate filtration data or from internal pressure-drop gradient data provided the Kozeny constant is treated as a variable.

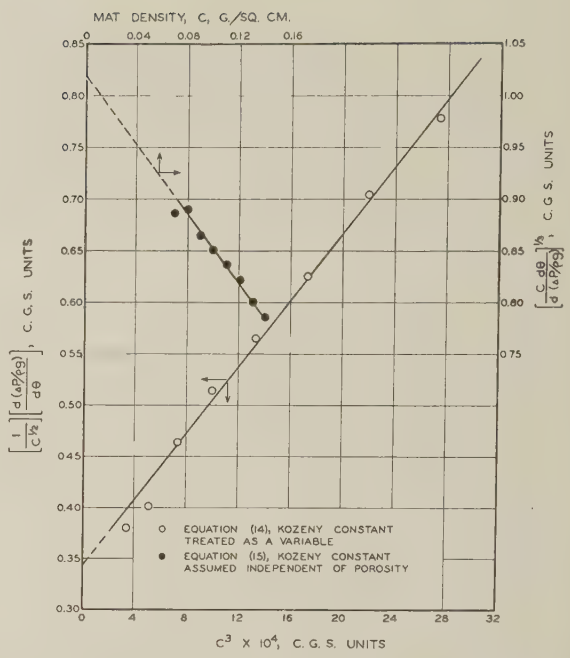

Fig. 15. Rectified Kozeny-Carman equation relationship from constant-rate filtrations of wood pulp

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Nomenclature

A = cross-sectional area of bed perpendicular to the direction of flow, square centimeters
a = empirical constant in Kozeny constant function, dimensionless
B = constant in filtration equation, $B = A^2/\mu Cq^2$, c.g.s. units
b = empirical constant in Kozeny constant function, dimensionless
C = mass of fibers in a filter bed per unit volume of filtrate, grams per cubic centimeter
c = bed density, grams per cubic centimeter
D_{sv} = surface-weighted average fiber diameter, centimeters
g = acceleration due to gravity, centimeters per second squared
k = Kozeny constant, dimensionless
L = total thickness of fiber mat, centimeters
l = distance from fiber mat face to a point within the mat, centimeters
M, N = constants in compressibility function, $c = Mp_s^N$, c.g.s. units
P = hydrostatic fluid pressure in a fiber mat, dynes per square centimeter
ΔP = over-all frictional pressure drop across fiber mat, dynes per square centimeter
Δp = frictional pressure drop from mat face to a point in the mat, dynes per square centimeter
p_s = mechanical compacting pressure, dynes per square centimeter
q = volumetric flow rate, cubic centimeters per second
R = specific resistance of fiber mat, centimeters per gram
S_v = fiber specific surface, square centimeters per cubic centimeter
S_w = fiber specific surface, square centimeters per gram
v = hydrodynamic fiber specific volume, cubic centimeters per gram
W = mat basis weight, grams per square centimeter
ε = bed porosity, void volume per bed volume, dimensionless
θ = filtration time, seconds
ρ = fluid density, grams per cubic centimeter
μ = fluid viscosity, poises

Alkaline Hydrolysis of Representative Hardwoods

IV. Acid Hydrolysis of the Extractives of Representative Hardwoods

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The 75% *n*-propanol extracts of 46 representative hardwoods were submitted to acid hydrolysis with boiling dilute sulphuric acid. The acid hydrolyzates were analyzed qualitatively and quantitatively by paper chromatographic and spectrophotometric procedures for phenolic materials and for sugars. In addition, the original extractives were analyzed for sugars. The extractives of all hardwoods tested yielded vanillin, vanillic acid, syringaldehyde, and syringic acid upon acid hydrolysis. Yields of vanillic and syringic acids were higher in this case than in the previously reported alkaline hydrolyses of the same propanol extractives, indicating a probable glycosidic linkage for these acids in the extractives. The yields of *p*-hydroxybenzoic acid from the acid hydrolyses of the extractives of *Salicaceae* family woods were much less than from the corresponding alkaline hydrolyses of these extractives, indicating an ester linkage in these instances. Most of the compounds found regularly in alkaline hydrolyses were found only in relatively few acid hydrolyses. These results, together with the specific sugar-yielding ability of individual wood extractives, suggest possible taxonomic applications.

In a previous paper (*1*) the 75% *n*-propanol extractives of 46 representative hardwoods were hydrolyzed with boiling sodium hydroxide solution, and the hydrolyzates were analyzed quantitatively for vanillin, syringaldehyde, *p*-hydroxybenzaldehyde, vanillic acid, syringic acid, *p*-hydroxybenzoic acid, *p*-coumaric acid, and ferulic acid, and qualitatively for other materials. In addition, hydrolysis data were compared with similar data from the same whole woods (*2*, *3*). The same propanol extractives of these 46 representative hardwoods were also subjected to acid hydrolysis with dilute sulphuric acid, and the present paper reports analytical data for sugars and phenolic materials liberated during these acid hydrolyses.

Acid hydrolysis mixtures were cooled and extracted with ether. The yields of ether solubles were determined, and concentrated ether extracts were chromatographed directly on paper and developed in butanol saturated with 2% aqueous ammonia and in 10:3:3 butanol-pyridine-water. Qualitative data for the butanol–aqueous ammonia developer are given in Table I and for the butanol-pyridine-water developer in Table II. Where found, vanillin, syringaldehyde, *p*-hydroxybenzaldehyde, vanillic acid, syringic acid, *p*-hydroxybenzoic acid, ferulic acid, and *p*-coumaric acid were then determined quantitatively by the paper chromatographic and spectrophotometric procedures described earlier (*2*, *3*). The quantitative data for these phenolic materials are given in Table III which also includes the original yield of 75% *n*-propanol extractives, the yield of ether extractives after acid hydrolysis, and the yield of water-insoluble, ether-insoluble tar after acid hydrolysis.

The acid hydrolyzates after extraction with ether were purified and chromatographed on paper to determine qualitatively the nature of the sugars present. Papers were developed in 10:3:3 butanol-pyridine-water and 9:2:2 ethyl acetate–acetic acid–water systems at 20°. Galactose, glucose, mannose, arabinose, xylose, and rhamnose were identified on the chromatograms. Where indicated, these sugars were then determined quantitatively by the paper chromatographic and spectrophotometric method of Timell, Glaudemans, and Currie (*4*) as modified by Dubey and co-workers (*5*). Quantitative sugar data are given in Table IV. In addition to the sugar yields after acid hydrolysis,

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Table I. Chromatographic Data for Phenolic Materials in Butanol-2% Aqueous Ammonia Developer

	Butanol-2% aqueous ammonia R_f[a]										
	0.00	0.06[b]	0.08[c]	0.10[d]	0.12[e]	0.21	0.38[f]	0.44[g]	0.67	0.79	0.88
Salix nigra	X	..	X	X	X	..	X	X	X	..	X
Salix babylonica	X	..	X	X	X	..	X	X	..	..	X
Salix eriocephala	X	..	X	X	X	X	X	X	..	X	X
Populus tremuloides	X	..	X	X	X	..	X	X[h]	X	..	X
Populus grandidentata	..	..	X	X	X	..	X	X	..	..	X
Populus tacamahaca	X	..	X	X	X	..	X	X	..	X	X
Populus deltoides	X	..	X	X	X	..	X	X	..	..	X
Populus trichocarpa	X	..	X	X	X	..	X	X	X	X	X
Populus alba	..	..	X	X	X	..	X	X	..	..	X
Populus nigra	X	..	X	X	X	..	X	X	..	..	X
Populus tremula	X	..	X	X	X	..	X	X	X	X	X
Juglans cinerea	X	X	X	X	..	..	X	X	..	X	X
Carya ovata	X	..	X	X	..	..	X	X	X	X	X
Betula lutea	X	..	X	X	..	X	X	X	X	..	X
Betula papyrifera	X	..	X	X	..	..	X	X	X	..	X
Alnus rubra	..	..	X	X	..	..	X	X	..	..	X
Carpinus caroliniana	X	..	X	X	..	..	X	X	..	..	X
Fagus grandifolia	X	..	X	X[i]	X	..	X	X	X	X	X
Castanea dentata	X	..	X	X	..	..	X	X	..	..	X
Auercus alba	X	..	X	X	..	..	X	X	X	..	X
Quercus lyrata	X	..	X	X	..	..	X	X	X	..	X
Quercus borealis	X	X	X	X	..	..	X	X	X	..	X
Quercus velutina	X	X	X	X	..	..	X	X	X	X	X
Quercus falcata	X	X	X	X	..	..	X	X	..	..	X
Quercus coccinea	X[b]	..	X	X	..	..	X	X	..	..	X
Quercus marilandica	X	..	X	X	..	..	X	X	..	..	X
Quercus catesbaei	X	..	X	X	..	..	X	X	..	X	X
Quercus phellos	X	..	X	X	..	..	X	X	..	..	X
Quercus nigra	X	..	X	X	..	..	X	X	X	..	X
Ulmus americana	X	..	X	X	..	..	X	X	..	X	X
Magnolia grandiflora	X	..	X	X	..	..	X	X	..	..	X
Magnolia virginiana	..	..	X	X	..	..	X	X	..	..	X
Magnolia fraseri	..	..	X	X	..	..	X	X	X	..	X
Liriodendron tulipifera	..	..	X	X	..	..	X	X	..	..	X
Liquidambar styraciflua	X	..	X	X	..	..	X	X	..	..	X
Platanus occidentalis	X	..	X	X	X[j]	..	X	X	X	..	X
Acer saccharum	..	..	X	X	..	..	X	X	..	..	X
Acer rubrum	X	..	X	X	..	..	X	X	..	..	X
Acer saccharinum	X	..	X	X	..	X	X	X	..	X	X
Acer negundo	..	..	X	X	..	..	X	X	..	..	X
Tilia americana	X	..	X	X	..	X	X	X	..	..	X
Tilia heterophylla	X	..	X	X	..	X	X	X	..	..	X
Nyssa aquatica	X	..	X	X	..	..	X	X	..	..	X
Nyssa sylvatica	X	..	X	X	..	..	X	X	X	..	X
Fraxinus nigra	..	..	X	X	..	..	X	X	..	X	X
Catalpa speciosa	X	..	X	X[i]	X	..	X	X	..	X	X

[a] R_f determined by means of bis-diazotized benzidine spray.
[b] This spot is positive to Mäule spray reagents.
[c] Syringic acid.
[d] Vanillic acid.
[e] *p*-Hydroxybenzoic acid.
[f] Syringaldehyde.
[g] Vanillin.
[h] This spot also contains *p*-hydroxybenzaldehyde.
[i] This spot also contains ferulic acid.
[j] This spot also contains *p*-coumaric acid.

Table IV also records the quantitative data for the sugars present in the 75% *n*-propanol extractives before acid hydrolysis.

EXPERIMENTAL PROCEDURE

Hydrolysis Procedure

A sample of the 75% *n*-propanol extract (*1*) containing 2.0 g. of solids was placed in a 250-ml. round-bottomed flask and evaporated to dryness under reduced pressure in a rotating evaporator. The residue was covered with 100 ml. of 0.5 *N* sulphuric acid, and the mixture was boiled under reflux for 4 hr. The mixture was cooled and extracted with ether. The ether extract was concentrated to a small volume, and the concentrated ether solution was employed for obtaining the qualitative paper chromatographic data of Tables I and II and the quantitative data of Table III. These data were obtained by procedures described in detail in a previous paper (*1*). Solids determination was also made on this concentrated ether solution to give the ether extract yield data of Table III.

After ether extraction of the acid-aqueous mixture, a considerable amount of tarry material remained undissolved. The aqueous solution was filtered, and the insoluble material was washed thoroughly with water and dissolved in ethanol. The clear ethanol solution was evaporated to dryness and weighed to give the yield of insoluble tar recorded in Table III.

Analysis for Sugars

The combined aqueous solution after ether extraction and washings of the insoluble tar was evaporated somewhat under reduced pressure to remove all traces of ether and passed through a 60-ml. column of regenerated and washed Duolite A-7* anion-exchange resin. The resin was washed with water, and the combined effluent and washings were concentrated in the rotating evaporator under reduced pressure and made to volume to give the sugar solution used for quantitative estimations.

In accordance with the procedure of Dubey and co-workers (*5*) the sugar solutions were spotted quanti-

* Anion-exchange resin manufactured by Chemical Process Co., Redwood City, Calif.

Table II. Chromatographic Data for Phenolic Materials in 10:3:3 Butanol-Pyridine-Water

	10:3:3 Butanol-pyridine-water R_f[a]										
	0.00	0.03	0.10	0.12	0.22[b]	0.32[b]	0.38[c]	0.44[d]	0.56[e]	0.78[f]	0.84[g]
Salix nigra	..	..	..	..	..	..	X	X	X	X	X
Salix babylonica	..	..	..	..	..	..	X	X	X	X	X
Salix eriocephala	..	..	..	..	..	..	X	X	X	X	X
Populus tremuloides	X	..	..	..	..	..	X	X	X	X	X[h]
Populus grandidentata	..	..	..	..	..	..	X	X	X	X	X
Populus tacamahaca	..	..	..	..	..	..	X	X	X	X	X
Populus deltoides	..	..	..	..	..	..	X	X	X	X	X
Populus trichocarpa	X	..	..	..	..	..	X	X	X	X	X
Populus alba	..	..	..	..	..	..	X	X	X	X	X
Populus nigra	..	..	..	..	..	..	X	X	X	X	X
Populus tremula	X	..	..	..	..	..	X	X	X	X	X
Juglans cinerea	..	..	..	..	..	X	X	X	..	X	X
Carya ovata	X	..	X	..	..	..	X	X	..	X	X
Betula lutea	..	..	..	..	..	..	X	X	..	X	X
Betula papyrifera	..	..	..	..	..	..	X	X	..	X	X
Alnus rubra	..	..	..	..	..	..	X	X	..	X	X
Carpinus caroliniana	X	..	..	..	..	..	X	X	..	X	X
Fagus grandifolia	..	..	..	..	..	..	X	X[i]	X	X	X
Castanea dentata	..	..	X	..	..	..	X	X	..	X	X
Quercus alba	X	..	..	..	..	..	X	X	..	X	X
Quercus lyrata	..	..	X	..	..	..	X	X	..	X	X
Quercus borealis	..	..	..	..	X	X	X	X	..	X	X
Quercus velutina	..	..	..	..	X	..	X	X	..	X	X
Quercus falcata	..	..	X	..	X	..	X	X	..	X	X
Quercus coccinea	X	..	..	..	..	X	X	X	..	X	X
Quercus marilandica	..	..	X	..	..	..	X	X	..	X	X
Quercus catesbaei	..	..	..	X	..	..	X	X	..	X	X
Quercus phellos	X	..	..	..	..	..	X	X	..	X	X
Quercus nigra	X	X	X	..	..	..	X	X	..	X	X
Ulmus americana	..	..	..	..	..	..	X	X	..	X	X
Magnolia grandiflora	..	..	X	..	..	..	X	X	..	X	X
Magnolia virginiana	..	..	X	..	..	..	X	X	..	X	X
Magnolia fraseri	..	..	..	..	..	..	X	X	..	X	X
Liriodendron tulipifera	..	..	..	..	..	..	X	X	..	X	X
Liquidambar styraciflua	X	..	X	..	..	..	X	X	..	X	X
Platanus occidentalis	X	..	..	..	..	..	X	X	X[i]	X	X
Acer saccharum	..	..	..	..	..	..	X	X	..	X	X
Acer rubrum	..	X	X	..	..	..	X	X	..	X	X
Acer saccharinum	..	..	X	..	..	..	X	X	..	X	X
Acer negundo	..	..	..	..	..	..	X	X	..	X	X
Tilia americana	..	..	..	..	..	..	X	X	..	X	X
Tilia heterophylla	..	..	..	..	..	..	X	X	..	X	X
Nyssa aquatica	X	..	X	..	..	..	X	X	..	X	X
Nyssa sylvatica	..	..	X	..	..	..	X	X	..	X	X
Fraxinus nigra	..	..	..	..	..	..	X	X	..	X	X
Catalpa speciosa	..	..	..	..	..	..	X	X[i]	X	X	X

[a] R_f determined by means of bis-diazotized benzidine spray.
[b] This spot is positive to Mäule spray reagents.
[c] Syringic acid.
[d] Vanillic acid.
[e] *p*-Hydroxybenzoic acid.
[f] This spot contains syringaldehyde.
[g] This spot contains vanillin.
[h] This spot also contains *p*-hydroxybenzaldehyde.
[i] This spot also contains ferulic acid.
[j] This spot also contains *p*-coumaric acid.

tatively on Whatman No. 1 paper and developed in 10:3:3 butanol-pyridine-water for glucose, galactose, xylose, and rhamnose and in 9:2:2 ethyl acetate–acetic acid–water for mannose and arabinose. The papers were also spotted with known sugar solutions for reference purposes. The chromatographed papers were sprayed with *o*-aminobiphenyl reagent, and the spots were developed by heating and located by means of ultraviolet light. Located spots were cut from the paper along with paper blanks of the same size. The papers were extracted, and the extracts processed and analyzed for optical density at 380 mmu with a spectrophotometer. Yields of individual sugars were determined from the optical density measurements. Inasmuch as ribose was not found in any of the wood hydrolyzates, 50 mg. of ribose was added to each hydrolysis mixture immediately after the boiling was finished. The total yield of ribose was determined along with the other sugars, and from the recovery of ribose from the chromatographic and spectrophotometric procedure, the actual values of other sugars were calculated.

Sugars before Acid Hydrolysis

A sample of the 75% *n*-propanol extractives containing 2.0 g. of solids was evaporated to dryness in a 250-ml. round-bottomed flask in a rotating evaporator. The residue was covered with 100 ml. of water, and the mixture was boiled under reflux for 1 hr., filtered through a pad of diatomaceous filter aid, and concentrated to a small volume. The concentrated solution was again filtered through a pad of filter aid, made to volume, and analyzed in the same manner described for the acid hydrolyzates.

DISCUSSION OF RESULTS

The yields of ether extracts obtained after acid hydrolysis of the propanol extractives of the 46 woods ranged from a low of 5.0% in the cases of overcup oak and tupelo gum to a high of 52.0% in the case of bigtooth aspen. Although no family relationships were apparent, yields from the *Salix* and *Populus* species were relatively high and yields from the *Quercus* species were relatively low. The values for ether extract

yields in Table III are on the basis of the 75% *n*-propanol extractives. Actual yields on the basis of the original wood may be obtained by using the propanol extractives yield data.

Qualitative chromatography of the ether extractives indicated some interesting relationships (Tables I and II). As in the corresponding alkaline hydrolyses (*1*) the propanol extractives of all 46 woods yielded vanillin, syringaldehyde, vanillic acid, and syringic acid. This finding indicates that the extractives of all these representative hardwoods contain some guaiacyl and syringyl structures capable of yielding the aldehydes and acids by acid hydrolysis as well as by alkaline hydrolysis in accordance with the proposal of Wacek and Kratzl (*6*). Such structures may include glycoside or ester-linked compounds.

In addition to vanillin, syringaldehyde, vanillic acid, and syringic acid the propanol extract of every wood yielded upon acid hydrolysis material with butanol-aqueous ammonia R_f of approximately 0.88. None of these spots were positive toward 2,4-dinitrophenylhydrazine or Mäule spray reagents, indicating no carbonyl or syringyl activity. It is improbable that the R_f 0.88 spot is the same compound in all cases because many phenolic materials with substantially no acidity possess this R_f in this alkaline solvent system. Nothing further can be noted concerning this spot until the nature of the compound or compounds responsible for the spot are isolated.

Several items of taxonomic interest are apparent from the qualitative data of Tables I and II. Parahydroxybenzoic acid was found in the acid hydrolyzates of every wood extract which also yielded the acid upon alkaline hydrolysis (*1*). In addition to all members of the *Salicaceae* family, *Platanus occidentalis*, and *Catalpa speciosa* which gave *p*-hydroxybenzoic acid upon alkaline hydrolysis, the propanol extract of beechwood (*Fagus grandifolia*) yielded this acid upon acid hydrolysis, but did not upon alkaline hydrolysis. These data suggest a glycoside type of linkage of a *p*-hydroxybenzoic acid moiety in beechwood.

Only a few of the woods tested did not give a spot with butanol-aqueous ammonia R_f 0.0. Only in the case of *Quercus coccinea* was this spot positive to the Mäule spray reagents. These data should be useful for differentiation of species within a group. The Mäule positive spot at butanol-aqueous ammonia R_f 0.06 appeared in very few species as did the spots at R_f's 0.67 and 0.79. Ferulic acid was found in the acid hydrolyzates of the extracts of only two species, *Fagus grandifolia* and *Catalpa speciosa*, *p*-coumaric acid in only one species, *Platanus occidentalis*, and *p*-hydroxybenzaldehyde in only one species, *Populus tremuloides*, even though these compounds were found in the alkaline hydrolyzates of the extractives of many species. Again it appears that hydrolysis of glycoside or ester linkages are involved in the production of these compounds in the cases of the particular species in question. As in the case of aspenwood where *p*-hydroxybenzoic acid has been shown to be a sort of "common denominator" (*7*), these other compounds or moieties responsible for their production may play similar roles in other species. Under these conditions, glycosidic and ester types of linkages would be expected.

A number of other spots in both developing systems were obtained for only certain members of a particular genus or family and should have taxonomic implications.

The quantitative data of Table III indicate that the yields of all known compounds except vanillic and syringic acids are generally much lower under conditions of acid hydrolysis than under conditions of alkaline hydrolysis reported earlier (*1*). In the cases of vanillic and syringic acids, the yields from acid hydrolyses are generally higher than from corresponding alkaline hydrolyses both on the basis of the ether extract and on the basis of the original 75% *n*-propanol extract. Thus, it appears that vanillic and syringic acids are probably linked glycosidically in the propanol extractives. Such glycosidically linked vanillic and syringic acids would also be liberated by alkaline hydrolysis (*8*), but probably not in as good yield. It is possible that all vanillic and syringic acids found in the alkaline hydrolyzates of these *n*-propanol extractives were due to hydrolysis of glycosidically linked material and not to hydrolysis of an acyloin structure in one of its possible precursory forms as hypothesized earlier (*1*).

The yields of *p*-hydroxybenzoic acid in the acid hydrolyzates of *Catalpa speciosa*, *Platanus occidentalis*, and *Fagus grandifolia* extractives were higher than corresponding yields from alkaline hydrolyzates of these extractives, indicating the likelihood of glycosidically linked *p*-hydroxybenzoic acid in these woods. On the other hand, the yields of *p*-hydroxybenzoic acid from the acid hydrolyzates of the extractives of woods of the *Salicaceae* family were much lower than the corresponding yields from alkaline hydrolyzates of these extractives, thus confirming the hypothesis for ester-linked *p*-hydroxybenzoic acid in these woods first noted by Smith (*9*) for *Populus tremula*.

Ratios of guaiacyl and syringyl aldehydes and acids could not be generalized. Differences between acid and alkaline hydrolysis did appear, and these might have significance, but because only single samples were involved, no conclusions can be drawn.

The quantitative sugar data of Table IV indicate that glucose was present in the propanol extractives of every wood tested except *Populus trichocarpa* even before hydrolysis and in the acid hydrolyzates of the extractives of every wood tested. It should be noted that the increase in glucose yield was especially large in those instances where large yields of vanillic and/or syringic acid were obtained, thus confirming the possible glycosidic linkages for these two acids in the original extractives. It is interesting to note that *Populus trichocarpa* was the only wood tested that did not yield any sugar other than glucose upon acid hydrolysis. The probable occurrence of glycosides of vanillic acid and syringic acid and possibly of vanillin and syringaldehyde in the extractives of all hardwoods suggest interesting biosynthesis possibilities.

Galactose was obtained from all but nine wood extractives after acid hydrolysis even though most of the extractives did not contain any galactose before. The galactose yields followed no family lines, and failure to yield galactose appeared to be specific for individual species. Mannose was found to be present in about the same number of wood extractives before hydrolysis as was galactose, but its occurrence appeared to follow

Table III. Acid Hydrolysis of 75% Propanol Extracts of Hardwoods

Wood		75% propanol extract, %[a]	Ether extract, %[b]	Vanillin, %[c]	Spring-aldehyde, %[c]	p-Hydroxy-benzaldehyde %[c]	Vanillic acid, %[c]	Syringic acid, %[c]	p-Hydroxy-benzoic acid, %[c]	p-Coumaric acid, %[c]	Ferulic acid, %[c]	Insoluble tar, %[b]
Common name	*Scientific name*											
Black willow	*Salix nigra*	2.91	10.5	1.0	1.0	0.0	5.5	4.0	2.5	0.0	0.0	54.5
Weeping willow	*Salix babylonica*	5.28	32.5	0.2	0.4	0.0	1.6	2.2	2.2	0.0	0.0	43.0
Diamond willow	*Salix eriocephala*	5.52	45.0	0.3	0.4	0.0	0.9	1.9	0.9	0.0	0.0	36.0
Quaking aspen	*Populus tremuloides*	4.12	30.5	0.3	0.4	0.4	1.6	2.3	7.9	0.0	0.0	59.0
Bigtooth aspen	*Populus grandidentata*	3.42	52.0	0.2	0.2	0.0	1.0	1.1	2.3	0.0	0.0	36.0
Balsam poplar	*Populus tacamahaca*	3.50	25.5	0.5	0.4	0.0	2.1	2.0	1.7	0.0	0.0	62.0
Cottonwood	*Populus deltoides*	2.13	18.5	0.8	0.7	0.0	3.8	3.5	2.8	0.0	0.0	57.0
No. black cottonwood	*Populus trichocarpa*	2.33	20.0	2.2	1.6	0.0	3.0	3.0	14.3	0.0	0.0	54.0
European white poplar	*Populus alba*	3.38	21.5	1.4	0.8	0.0	2.3	2.5	6.0	0.0	0.0	51.0
Lombardy poplar	*Populus nigra*	3.81	17.0	0.6	0.8	0.0	1.8	1.9	4.0	0.0	0.0	50.0
European poplar	*Populus tremula*	4.60	27.5	0.2	0.4	0.0	2.0	1.6	2.5	0.0	0.0	59.0
Butternut	*Juglans cinerea*	9.46	24.0	0.4	0.6	0.0	4.6	3.8	0.0	0.0	0.0	18.5
Shagbark hickory	*Carya ovata*	4.98	16.0	1.0	1.1	0.0	6.2	8.1	0.0	0.0	0.0	26.0
Yellow birch	*Betula lutea*	1.24	12.0	0.6	1.0	0.0	3.7	4.0	0.0	0.0	0.0	51.0
Paper birch	*Betula papyrifera*	1.95	37.0	0.2	0.3	0.0	1.3	1.5	0.0	0.0	0.0	58.0
Red alder	*Alnus rubra*	2.78	14.5	0.7	0.5	0.0	3.5	7.3	0.0	0.0	0.0	51.0
American hornbeam	*Carpinus caroliniana*	2.01	10.5	1.1	1.1	0.0	6.1	5.9	0.0	0.0	0.0	58.0
Beech	*Fagus grandifolia*	1.82	17.5	0.7	1.4	0.0	5.8	7.4	2.0	0.0	1.9	63.0
Chestnut	*Castanea dentata*	8.15	11.0	1.6	1.8	0.0	5.0	5.7	0.0	0.0	0.0	20.0
White oak	*Quercus alba*	6.40	7.5	1.0	1.3	0.0	10.0	11.0	0.0	0.0	0.0	38.0
Overcup oak	*Quercus lyrata*	6.40	5.0	3.5	2.3	0.0	10.3	6.5	0.0	0.0	0.0	42.0
Eastern red oak	*Quercus borealis*	6.20	6.5	2.7	2.3	0.0	5.8	12.7	0.0	0.0	0.0	33.0
Black oak	*Quercus velutina*	6.58	8.5	1.1	1.4	0.0	6.1	4.0	0.0	0.0	0.0	37.0
Southern red oak	*Quercus falcata*	4.11	6.0	2.9	2.8	0.0	14.0	9.6	0.0	0.0	0.0	46.0
Scarlet oak	*Quercus coccinea*	6.27	10.5	1.7	1.9	0.0	8.0	9.0	0.0	0.0	0.0	31.0
Blackjack oak	*Quercus marilandica*	2.72	7.0	2.4	2.9	0.0	12.5	12.9	0.0	0.0	0.0	55.0
Turkey oak	*Quercus catesbaei*	4.75	15.0	1.3	1.8	0.0	4.5	4.3	0.0	0.0	0.0	33.0
Willow oak	*Quercus phellos*	3.07	6.0	2.5	4.6	0.0	8.9	9.0	0.0	0.0	0.0	25.0
Water oak	*Quercus nigra*	1.86	8.5	0.9	0.9	0.0	5.0	4.6	0.0	0.0	0.0	60.0
American elm	*Ulmus americana*	2.18	6.0	2.1	2.1	0.0	14.0	12.8	0.0	0.0	0.0	56.0
Southern magnolia	*Magnolia grandiflora*	1.48	6.0	2.5	2.9	0.0	13.8	11.7	0.0	0.0	0.0	62.0
Sweet bay	*Magnolia virginiana*	1.69	8.5	2.1	1.5	0.0	9.7	6.4	0.0	0.0	0.0	58.0
Fraser magnolia	*Magnolia fraseri*	2.60	10.5	3.1	2.4	0.0	15.7	13.5	0.0	0.0	0.0	37.0
Yellow poplar	*Liriodendron tulipifera*	1.63	9.0	0.8	1.3	0.0	4.2	3.8	0.0	0.0	0.0	57.0
Sweetgum	*Liquidambar styraciflua*	0.98	12.5	0.9	1.0	0.0	3.5	3.6	0.0	0.0	0.0	61.0
American sycamore	*Platanus occidentalis*	1.72	28.5	0.9	1.3	0.0	3.7	3.7	2.9	2.4	0.0	44.0
Sugar maple	*Acer saccharum*	2.00	9.5	1.6	1.6	0.0	5.4	8.4	0.0	0.0	0.0	51.0
Red maple	*Acer rubrum*	2.42	9.5	0.8	0.8	0.0	5.7	6.2	0.0	0.0	0.0	55.0
Silver maple	*Acer saccharinum*	4.50	30.5	0.5	0.6	0.0	1.5	2.2	0.0	0.0	0.0	51.5
Box elder	*Acer negundo*	3.08	13.5	1.1	0.9	0.0	3.9	1.9	0.0	0.0	0.0	48.0
Basswood	*Tilia americana*	4.27	38.5	0.5	0.6	0.0	1.7	2.2	0.0	0.0	0.0	48.0
White basswood	*Tilia heterophylla*	4.67	18.0	0.7	0.7	0.0	2.4	2.6	0.0	0.0	0.0	64.0
Tupelo gum	*Nyssa aquatica*	5.15	5.0	4.0	3.0	0.0	8.8	8.5	0.0	0.0	0.0	53.0
Black gum	*Nyssa sylvatica*	1.29	44.0	0.2	0.2	0.0	1.8	2.1	0.0	0.0	0.0	55.0
Black ash	*Fraxinus nigra*	3.42	19.0	0.5	1.3	0.0	4.4	4.2	0.0	0.0	0.0	36.5
Northern catalpa	*Catalpa speciosa*	5.08	15.5	1.9	3.1	0.0	3.8	6.6	3.5	0.0	5.7	51.5

[a] Solids on basis of oven-dry wood.
[b] Solids in ether extract of acid hydrolyzate based on 75% propanol extractives.
[c] Basis of solids in ether extract.

Table IV. Sugars in 75% Propanol Extracts of Hardwoods Before and After Acid Hydrolysis

Wood		Galactose, %[a]		Glucose, %		Mannose, %		Arabinose, %		Xylose, %		Rhamnose, %	
Common name	Scientific name	B[b]	A[c]	B	A	B	A	B	A	B	A	B	A
Black willow	*Salix nigra*	0.0	1.3	0.6	1.7	0.4	0.8	0.0	0.0	0.0	0.0	0.0	0.0
Weeping willow	*Salix babylonica*	1.5	4.8	15.8	24.8	0.8	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Diamond willow	*Salix eriocephala*	0.0	0.7	1.2	4.6	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Quaking aspen	*Populus tremuloides*	0.0	0.6	0.4	1.1	0.0	0.3	0.0	0.0	0.0	0.7	0.0	0.0
Bigtooth aspen	*Populus grandidentata*	0.2	1.3	1.2	2.5	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Balsam poplar	*Populus tacamahaca*	0.0	1.1	1.4	3.4	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0
Cottonwood	*Populus deltoides*	0.0	0.8	1.5	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
No. black cottonwood	*Populus trichocarpa*	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
European white poplar	*Populus alba*	1.1	1.4	1.9	5.6	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0
Lombardy poplar	*Populus nigra*	0.4	1.3	1.0	5.2	0.7	3.9	0.0	0.0	0.0	0.0	0.0	0.0
European poplar	*Populus tremula*	0.5	0.3	10.4	15.3	0.7	0.6	0.0	0.0	0.0	0.0	0.0	1.0
Butternut	*Juglans cinerea*	0.0	0.9	5.4	7.2	0.8	1.4	0.0	0.0	0.0	0.0	0.0	0.0
Shagbark hickory	*Carya ovata*	0.0	0.0	14.3	22.0	0.0	1.0	0.0	1.0	0.0	1.2	0.0	0.0
Yellow birch	*Betula lutea*	0.0	0.8	0.4	1.8	0.0	0.3	0.0	0.0	0.5	1.6	0.0	0.0
Paper birch	*Betula papyrifera*	0.0	0.0	0.7	2.2	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0
Red alder	*Alnus rubra*	0.6	1.6	4.1	12.3	0.3	0.6	0.0	0.0	1.4	3.5	0.0	0.0
American hornbeam	*Carpinus caroliniana*	0.0	0.6	1.7	2.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Beech	*Fagus grandifolia*	0.0	0.6	0.5	0.9	0.0	0.0	1.3	1.9	0.0	0.0	0.0	0.0
Chestnut	*Castanea dentata*	0.0	0.7	2.6	3.2	0.3	0.3	0.8	1.8	0.0	0.0	0.0	0.0
White oak	*Quercus alba*	0.0	1.1	7.1	12.2	0.0	0.0	1.7	2.0	1.0	2.2	0.3	0.8
Overcup oak	*Quercus lyrata*	0.0	1.1	1.9	6.3	0.0	0.7	0.8	1.6	1.0	1.7	0.0	0.6
Eastern red oak	*Quercus borealis*	0.0	0.3	2.5	6.2	0.0	0.5	0.0	1.3	0.5	1.6	0.5	1.7
Black oak	*Quercus velutina*	0.0	0.0	8.4	17.9	0.0	0.0	0.0	1.8	0.0	2.3	1.3	3.0
Southern red oak	*Quercus falcata*	0.0	0.7	1.2	2.0	0.0	0.8	1.5	2.3	0.0	1.2	0.0	0.7
Scarlet oak	*Quercus coccinea*	0.0	1.1	7.9	11.5	0.0	0.0	0.9	1.8	0.8	1.9	0.7	1.3
Blackjack oak	*Quercus marilandica*	0.0	0.0	1.1	1.7	0.2	0.5	0.0	0.0	0.0	2.4	0.0	0.0
Turkey oak	*Quercus catesbaei*	0.0	1.1	2.7	8.8	0.0	0.0	0.0	1.0	0.0	2.7	0.0	0.0
Willow oak	*Quercus phellos*	0.3	1.1	5.6	10.0	0.0	0.8	0.0	0.0	0.0	1.4	0.0	1.4
Water oak	*Quercus nigra*	0.0	1.5	1.0	3.2	0.7	1.0	0.0	1.6	0.0	0.9	0.0	0.0
American elm	*Ulmus americana*	0.7	2.2	7.5	16.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Southern magnolia	*Magnolia grandiflora*	0.0	1.4	1.7	2.8	0.3	1.3	0.0	0.0	0.0	0.0	0.0	0.0
Sweetbay	*Magnolia virginiana*	0.0	0.9	0.6	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Fraser magnolia	*Magnolia fraseri*	0.6	1.1	5.0	12.5	0.7	1.1	0.0	0.0	0.0	0.8	0.0	0.0
Yellow poplar	*Liriodendron tulipifera*	0.0	0.0	4.1	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sweet gum	*Liquidambar styraciflua*	0.0	0.8	4.7	6.3	0.4	0.6	0.0	0.7	0.0	0.9	0.0	0.0
American sycamore	*Platanus occidentalis*	0.5	0.9	1.2	2.0	0.0	0.7	0.0	1.1	0.0	0.0	0.5	1.0
Sugar maple	*Acer saccharum*	0.0	0.0	0.4	1.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Red maple	*Acer rubrum*	0.0	1.2	1.1	2.6	0.3	2.1	0.0	1.7	0.0	0.0	0.0	0.0
Silver maple	*Acer saccharinum*	0.0	0.7	2.5	8.5	0.0	0.0	0.0	1.0	0.0	1.0	0.0	0.0
Box elder	*Acer negundo*	0.7	1.4	4.5	7.2	0.4	0.6	0.0	0.0	0.0	0.0	0.0	0.0
Basswood	*Tilia americana*	0.0	0.2	1.4	2.0	0.0	1.1	0.0	0.0	0.0	1.2	0.0	0.0
White basswood	*Tilia heterophylla*	0.0	2.4	3.6	7.4	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0
Tupelo gum	*Nyssa aquatica*	0.0	0.0	4.9	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Black gum	*Nyssa sylvatica*	0.0	1.1	0.6	4.0	0.0	0.6	0.0	0.0	0.0	0.4	0.0	0.0
Black ash	*Fraxinus nigra*	0.0	0.0	2.5	5.9	0.0	0.5	0.0	0.0	0.0	0.9	0.3	0.5
Northern catalpa	*Catalpa speciosa*	0.7	1.2	4.3	12.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4

[a] On basis of solids in 75% *n*-propanol extracts.
[b] Before hydrolysis.
[c] After hydrolysis.

family lines to some extent. The absence of mannose even after hydrolysis was noted for 15 wood extractives, and again family relationships existed.

Although xylose is the predominant sugar found in wood hydrolyzates of most representative hardwoods it was found in the extractives of very few woods before hydrolysis and in less than 50% of the wood extractives even after hydrolysis. In both cases, the oaks comprised a high percentage of the extractives yielding xylose. Much the same results were obtained for arabinose. Again, the oaks and other members of the *Fagaceae* family made up a large percentage of the wood extractives yielding arabinose before and after acid hydrolysis. Rhamnose was found in six wood extractives before hydrolysis and in 11 woods after hydrolysis. Again, the oaks comprised more than half of the wood extractives yielding rhamnose. This would be expected because of the fact that for years the inner bark of *Quercus velutina* has been the source of quercitin, the rhamnoside of quercitin employed as a dyestuff. It should be noted that *Catalpa speciosa* extractives gave a very high yield of rhamnose after hydrolysis even though none was found before hydrolysis. The nature of the glycoside responsible for this yield of rhamnose and of other glycosides indicated in this study is being investigated and will be the subject of future papers.

Again it should be noted that the results reported in this paper are still preliminary in nature because, in almost all cases, they reflect experimental data from single specimens of individual species. Possible variations discussed earlier (*2*) apply to the results and discussions contained herein.

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Cyanoethylation as a Means of Improving the Dimensional Stability of Paper

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An investigation of the properties of cyanoethylated paper was made with particular respect to dimensional stability. It was found that a substantial improvement in dimensional stability results when cyanoethylation is carried out on the pulp, rather than on performed sheets. The improvement is proportional to the degree of cyanoethylation when substitution is carried out in the range where morphology of the pulp is unaffected. In blends of cyanoethylated and untreated pulps, the expansivity is directly related to the ratio of the amounts of treated and untreated pulps in the blend. The improvement in dimensional stability is the result solely of etherification with acrylonitrile, as indicated by the fact that a control treated with alkali only showed no decrease in expansivity. A new process of cyanoethylation is described, involving the use of minimal quantities of both sodium hydroxide solution and acrylonitrile.

Dimensional stability of paper has previously been discussed by one of the authors (*1*). There are numerous ways of affecting dimensional stability; these include physical as well as chemical methods (*2*). Calkins has stated that the use of fibers which expand less with moisture, or any treatment which reduces internal bonding and makes bonds less susceptible to water, is likely to result in an improvement in dimensional stability (*3*).

Recently, considerable interest has been shown in a chemical modification of cellulose involving partial etherification with acrylonitrile under alkaline conditions. This process, called cyanoethylation, has resulted in textiles with increased resistance to rot and heat when reaction was carried out to nitrogen contents of 2 to 5%, corresponding to degrees of substitution (D.S.) of 0.25 to 0.75 (*4 to 7*). Significantly, cyanoethylated cellulose was also found to be more hydrophobic as indicated by the fact that the moisture content at equilibrium is lowered by over 25% (*4, 5*). Furthermore, partial cyanoethylation is believed to involve substitution at the most accessible hydroxyl groups. These are the same sites that can be expected to contribute most heavily not only to moisture pickup, but also to bonding in paper and, therefore, to expansivity. These considerations led us to believe that cyanoethylated paper might exhibit improved dimensional stability. A joint program was, therefore, initiated in 1955 to investigate this possibility, with cyanoethylation being carried out at Cyanamid and the pulps being evaluated at I.B.M. (*8*).

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PROCEDURE

Paper. In initial experiments, attempts were made to cyanoethylate performed sheets directly. Typically, sheets were first impregnated with 1.5% NaOH solution and then immersed in acrylonitrile for 10 min. at 50°C. The paper was then treated with dilute acetic acid, rinsed with water and dried. Analysis showed a nitrogen content of 3.7%, corresponding to a D.S. of 0.5.

The appearance of the treated paper was generally unsatisfactory and it appeared to have been weakened greatly. Differential dyeing by the method of Fordemwalt and Kourtz (*9*) showed that the extent of cyanoethylation was not uniform throughout the paper. Furthermore, this method of cyanoethylation resulted is a *loss* of dimensional stability. This loss was due to the strong swelling action of the alkali, as indicated by the fact that stock treated with the caustic only, in the absence of acrylonitrile, had still poorer stability. In addition, scale-up of the procedure was believed to involve great difficulties due to the weakened nature of the paper when wet with caustic. For these reasons, we preferred to carry out the cyanoethylation on the pulp before the papermaking process, and the remainder of this communication will deal with this approach. Unsatisfactory results were also recently reported by Stamm and Cohen in their independent attempts to cyanoethylate sheets of paper (*10*).

Pulp-Conventional Processes. Albacel bleached sulphate pulp (Riegel) was cyanoethylated by essentially the same procedures as those which had been found useful with cotton. Typically, the cellulose was allowed to steep for 15 min. in dilute sodium hydroxide solution, containing 0.1% Aerosol OS* wetting agent. It was then centrifuged to the minimum wet pickup and immersed in sufficient acrylonitrile (*ca.* 20 times the weight of the dry pulp) to permit vigorous agitation. Heat was then applied to maintain the mixture at the desired temperature. The reaction was stopped by neutralization of the alkali with dilute acetic acid. The pulp was thoroughly washed with water and analyzed for nitrogen content. This procedure is referred to as a two-step process because of the separate treating steps, first with caustic and then with acrylonitrile.

Alternatively, the dry pulp could be dispersed directly in the acrylonitrile, with the required amount of alkaline solution being added dropwise at room temperature, and the reaction then being carried out as before. This modification is called the one-step procedure (*6*). Specific conditions of cyanoethylation are

* Reg. U. S. Pat. Off.—American Cyanamid Co.

listed in Table I. In general, the cyanoethylation of paper pulp proceeds in the same way as that of cotton, except that it was found preferable to avoid alkali

Table I. Cyanoethylation of Pulp by Conventional Procedures

Procedure	Sodium hydroxide solution Ratio to cellulose	Conc., %	Reaction Time, min.	Reaction Temp., °C.	% Nitrogen	D.S.
Two-step	ca. 2	1.0	20	34–37	1.5	0.18
Two-step	ca. 2	2.0	18	40–45	3.4	0.45
Two-step	ca. 3	2.0	12	60–70	3.7	0.50
Two-step	ca. 2	3.0	20	54–60	4.4	0.61
One-step	ca. 3	4.0	20	50–60	4.9	0.70

concentrations higher than about 6% because of a tendency of pulp to become gelatinous.

Pulp—New Process. In order to avoid the large excess of acrylonitrile needed in the procedures described above, consideration was given to processes requiring only minimal quantities of acrylonitrile.

One such process involves the use of relatively large quantities of concentrated aqueous sodium hydroxide (*11*). In an extensive investigation of this method with cotton, Bikales and Rapoport found that products of inferior quality resulted, unless measures were taken to avoid excessive swelling (*7*). Improvements were noted when relatively small quantities (10 parts per part of cellulose) of alkali were used, and/or when the caustic was dilute. The latter condition was limited, however, by the need for a sodium hydroxide concentration of at least 8% in order to obtain an adequate degree of cyanoethylation.

It has now been found that even further improvements can be obtained by carrying out the reaction with minimal quantities of *both* liquid reagents, *i.e.*, sodium hydroxide solution and acrylonitrile. In a typical procedure, pulp is steeped in dilute sodium hydroxide solution (2 to 6%), centrifuged to the minimum wet pickup, and charged to an apparatus suitable for blending of solids. Acrylonitrile, in an amount no larger than the weight of dry pulp, is then added dropwise while the pulp is being agitated. Mixing is continued, preferably at room temperature, until the desired degree of cyanoethylation is obtained. The treatment is carried out in an atmosphere of nitrogen to minimize oxycellulose formation. The pulp is neutralized and recovered as in the conventional processes. As much as 60% of the acrylonitrile has been incorporated in the cellulose by this method. The pretreatment of the pulp can also be omitted, in which case the alkaline solution (no more than 1.5 part per part of cellulose) is added dropwise to the dry pulp in the mixer, followed by agitation to effect uniform distribution, and addition of acrylonitrile. The equipment which we used and found satisfactory was a commercial double-arm mixer manufactured by the Read Standard Corp. of York, Pa. The simplicity of this new process promises to make cyanoethylation of cellulose for papermaking economical.

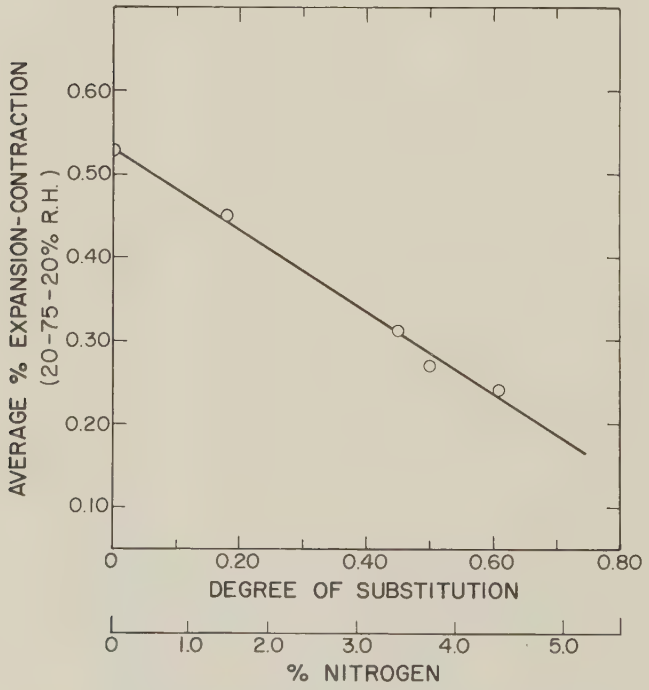

Fig. 1. Expansivity of cyanoethylated handsheets as a function of the degree of substitution

The preparation of the sample used for the studies described here involved pretreatment in 4% NaOH solution, containing 0.1% Aerosol OS wetting agent, centrifugation, and reaction with 1 part of acrylonitrile per part of cellulose for 3 hr. at room temperature. Nitrogen content of the product was 4.1% (D.S. = 0.56).

A 1.5-lb. Valley beater was used on the pulp at a consistency of 1.56%. Handsheets (either four or five for each freeness) were made from a 1.0% consistency suspension on a square mold ($8^1/_2$ by $8^1/_2$-in.) with a 100-mesh wire. After having been pressed flat between blotters for 30 sec. on a hydraulic press, the sheets were dried at 105°C. Precautions were taken to minimize restriction of shrinkage during drying on the slightly curved drier surface. The handsheets were then brought to equilibrium by exposure in the 50% R.H. room and physical testing performed. Schopper tensile measurements were made on 1-in. strips cut along both directions of the handsheets. Squares measuring 3.250 by 3.250 in. were cut from each sample on a precision cutter. Expansivity values were then obtained by conditioning to equilibrium and measuring dimensions of the squares in both directions successively at 50, 20, 50, 75, 50, 20, and 50% R.H. in three rooms held at the required relative humidities. Dimensions were obtained by using appropriate gages and estimating to the nearest ten-thousandth of an inch (*1*). The expansion or contraction was then expressed as a per cent change from 3.250 in. over the range of relative humidities indicated.

RESULTS

In order to ascertain the effect of the degree of cyanoethylation on paper characteristics, the sulphate pulp was beaten to a Canadian freeness of 500 and cyanoethylated to various nitrogen contents from 0.0 to 4.4%. The range chosen was such as to result in retention of morphology of the original pulp. Higher degrees of cyanoethylation are known to convert cellulose to an amorphous, thermoplastic material (*12*). Handsheets were then prepared from the treated pulp and their physical properties measured. The results are recorded in Table II. It can be seen that the expansivity underwent a striking decrease with

Table II. Properties of Cyanoethylated Handsheets—Bleached Sulphate

% Nitrogen → / *Canadian freeness →*	*0.0* / *500*	*1.5* / *540*	*3.4* / *630*	*3.7* / *650*	*4.4* / *665*
Basis weight ($22^1/_2 \times 28^1/_2$—500)	72.8	78.5	71.1	72.8	73.7
Caliper, $^1/_{1000}$ in.	10.1	10.1	10.4	10.6	10.8
Expansion, % (20–75% R.H.)	0.51	0.43	0.28	0.25	0.24
Contraction, % (75–20% R.H.)	0.55	0.47	0.33	0.28	0.24
Average % exp.-contr.	0.53	0.45	0.31	0.27	0.24
Improvement in expansivity, %	0.0	15	42	49	55
Tensile strength, (1-in width), lb.	47.3	55.5	34.9	31.1	26.6
Bursting strength (Mullen), p.s.i.	94	88	61	52	44
Folding endurance (M.I.T.)	1505	1296	161	134	75
Porosity (Gurley), sec.	89	56	8	6	5

increasing nitrogen content. This is illustrated in Fig. 1. The improvement appears to be a linear function of the degree of substitution. The tensile and bursting strengths, on the other hand, were adversely affected by cyanoethylation. Again the change was essentially linear with extent of cyanoethylation (Figs. 2 and 3). Chemical modification also made the sheets more porous and decreased the folding endurance. As can be seen in Table II, cyanoethylation increased the freeness of the pulp. It is not known whether the deviation at 1.5% *N* in Fig. 2 represents a real effect or experimental error. The fact that no such deviation is observed in Fig. 3 tends to support the latter explanation. However, it was recently claimed that optimum papermaking characteristics for cyanoethylated linters are at about 1.8% *N* (*13*).

The properties of blends of untreated pulp with varying proportions of cyanoethylated pulp were investigated. Pulp was beaten to a Canadian freeness of 500 and a portion was cyanoethylated to a nitrogen content of 4.9%. Inasmuch as the cyanoethylation treatment caused an increase in freeness to 660, blends

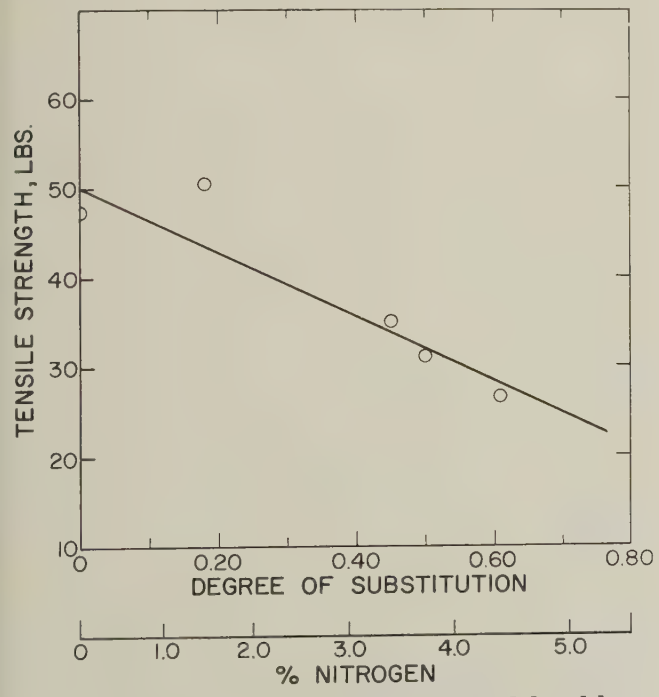

Fig. 2. Tensile strength of cyanoethylated handsheets as a function of the degree of substitution

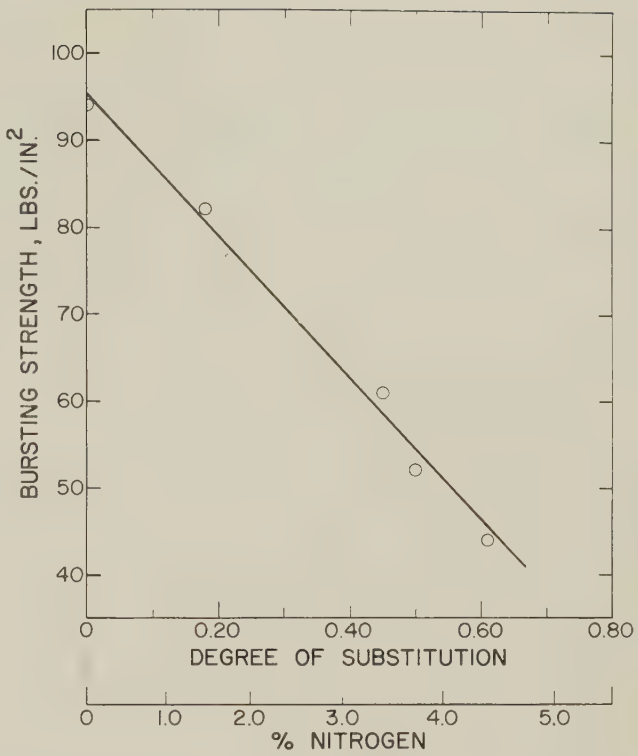

Fig. 3. Bursting strength (Mullen) of cyanoethylated handsheets as a function of the degree of substitution

were made with cyanoethylated pulp at the higher freeness as well as with pulp which had been beaten to 600 after cyanoethylation. All the various blends appeared to have a strictly linear relation of expansivity as a function of cyanoethylated cellulose content (Fig. 4). As expected, the more highly beaten pulp had a higher expansivity, but the difference was relatively small. The bursting strength decreased with increasing cyanoethylated cellulose content. The relationship appeared to deviate to some extent from linearity. The more highly beaten pulp had slightly greater strength (Fig. 5).

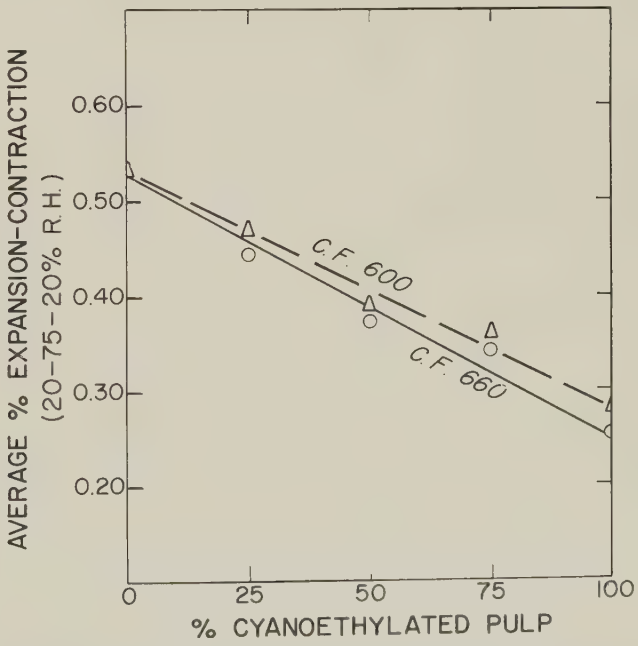

Fig. 4. Expansivity of handsheets made from mixtures of bleached sulphate with cyanoethylated bleached sulphate (4.9% N)

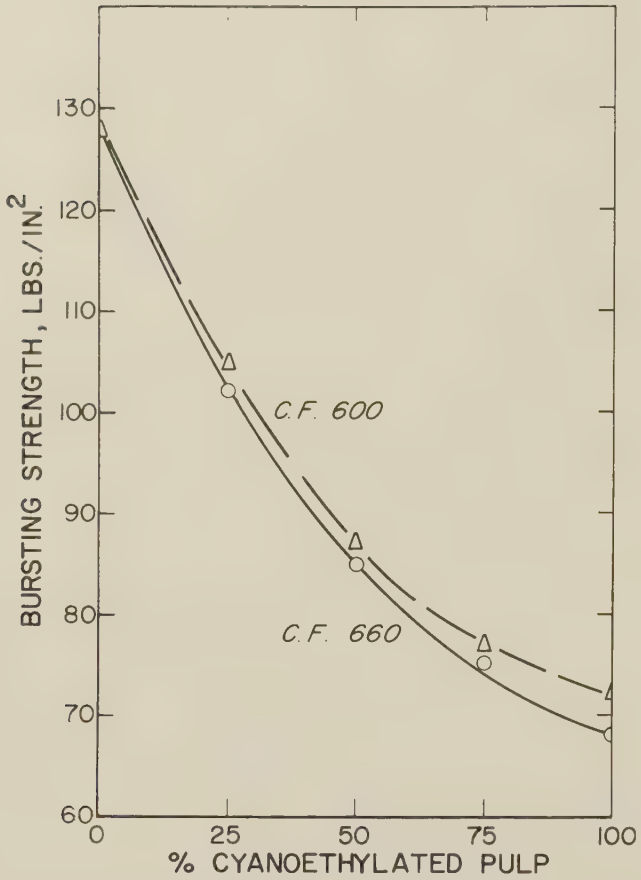

Fig. 5. Bursting strength (Mullen) of handsheets made from mixtures of bleached sulphate with cyanoethylated bleached sulphate (4.9% N)

Handsheets were also prepared from pulp treated by the new cyanoethylation process described above. Their dimensional stability was compared with that of handsheets made of untreated pulp, as well as with that of handsheets made of pulp which had been subjected to the action of alkali under conditions identical with those of cyanoethylation, but in the absence of acrylonitrile. In these experiments, comparisons were made at equal freeness values. The average expansion-contraction of the three pulps is illustrated in Fig. 6. It can be seen that here too the cyanoethylated pulp is markedly superior to the control. That this is due solely to the presence of cyanoethyl groups in the cellulose is demonstrated by the fact that the pulp treated with the alkali only showed no improvement over the untreated control. The actual values for the latter were slightly lower than those in Table II. This could be attributed to the fact that a different batch of bleached sulphate was used for these experiments and that this set of handsheets was prepared under slightly different conditions at Stamford. An interesting observation was that there appeared to be no significant change in hygroexpansivity with increasing length of beating for the cyanoethylated and for the alkali-treated pulps. The control, on the other hand, behaved in the usual fashion in that the expansivity increased with beating time.

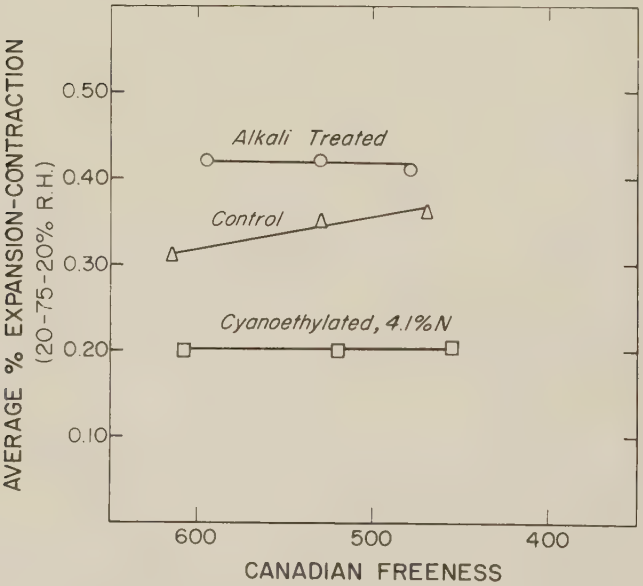

Fig. 6. Expansivity as a function of freeness of handsheets made from bleached sulphate cyanoethylated by the new process as compared with a control and a control treated with alkali only

CONCLUSIONS

Cyanoethylation of bleached sulphate pulp results in a substantial improvement in dimensional stability, a property of considerable interest. The improvement is proportional to the extent of cyanoethylation when substitution is carried out in the range where morphology of the pulp is unaffected. The expansivity in blends of untreated pulp with cyanoethylated pulp is in direct proportion to the ratio of pulps in the blend. These properties are the result solely of etherification with acrylonitrile, as indicated by the fact that a control treated with alkali only did not show any improvement in dimensional stability. The tensile strength of handsheets appears to be decreased to some extent by cyanoethylation. The combination of increased dimensional stability and decreased strength is consistent with the properties expected from the introduction of hydrophobic substituents in the cellulose.

A new, simplified process of cyanoethylation is described which should lend itself to use in the paper industry.

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New Method for Determination of Copper Number of Cellulose: Application to Viscose Rayon

JULIA E. MORGAN and CHARLES L. HENRY

The relationship between the number of reducing groups and color reversion in viscose rayon yarn was investigated. The reproducibility of the standard TAPPI copper number method was inadequate for detecting small differences in copper number which caused observable differences in color reversion. In the process of improving the reproducibility, a new method has been worked out. A finely divided 1-g. sample of yarn is boiled for 1 hr. with a 1:4 mixture of 60 g. per liter $CuSO_4 \cdot 5H_2O$ and of an alkaline solution containing 228 g. citric acid and 183 g. sodium hydroxide per liter. The cuprous oxide formed is oxidized with nitric acid to cupric ion and titrated complexometrically with standard EDTA using pyridine-2-azo-*p*-dimethyl aniline as indicator. All the reagents including the alkaline copper citrate are stable on storage or heating. Weight of sample, boiling time, and speed of filtration and titration are not critical. Duplicates check within 0.04 copper number. In addition to showing a relationship between small change (<0.2) in copper number and color reversion, a linear relationship between heat stability of rayon yarn and copper number was found. Results are somewhat higher than those obtained by the Hägglund modification of the standard method.

MANY investigators including Virkola (*1*), Pinte (*2*), and Rapson (*3*) have reported that the tendency of wood pulps and cotton to undergo color reversion, or yellowing on aging, is directly related to the number of reducing groups in the cellulose. To study the effects of reducing groups in viscose rayon on heat stability and color reversion, the copper number of viscose rayons bleached by various methods was determined by the standard TAPPI method (T 215 m-50) and the Hägglund modification. The precision of these was inadequate for the purpose. Duplicate determinations using the TAPPI and Hägglund methods check only within 0.2 copper number. In many rayon samples only slightly damaged by bleach or other degradative processes, the copper number did not vary as much as 0.2, even though distinct differences in color reversion were observed. In addition, the standard TAPPI method was too lengthy and involved for a large number of samples. Efforts to improve the precision of these methods resulted in a a simpler, more precise method for determination of the copper number which is reported herein as the Enka copper number of cellulose.

DEVELOPMENT OF THE ENKA COPPER NUMBER PROCEDURE

Copper number determinations are based on the reduction of copper(II) by cellulosic aldehyde groups in a hot, alkaline medium.

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$$R_{cell} - CHO + 2Cu^{++} + NaOH + H_2O \xrightarrow{100°C.} R_{cell} - COONa + Cu_2O\downarrow + 4H^+ \quad (1)$$

The quantity of Cu_2O formed is chemically equivalent to the groups oxidized in the cellulose, provided no side reactions occur. The copper number is expressed as the number of grams of copper(I) formed on reduction of copper(II) with 100 g. cellulose.

The Hägglund copper number method requires the mixing of the copper(II) and the alkaline complexing agent just prior to use because the copper(II) tartrate undergoes auto-oxidation in strongly alkaline solutions forming Cu_2O. In an actual analysis, this instability causes reaction time and temperature to be critical, as Cu_2O is continuously formed from copper(II) by a reduction process involving the secondary hydroxyl groups in the tartaric acid. Thus the longer the boiling time in an analysis the larger the blank correction. In the Enka copper number method, solution instability to aging, NaOH, and heating is eliminated by replacing tartaric acid with citric acid which has no secondary hydroxyl groups.

Determination of the Cu_2O formed is usually accomplished by quantitative oxidation-reduction reactions. Most of the solutions heretofore used are unstable and require frequent standardization. In the Enka method, excess copper(II) is removed from the Cu_2O by washing with a buffer; then copper(I) is oxidized to copper(II) with HNO_3 and titrated with standard EDTA. All solutions used in this procedure are stable and the volume of titrant is increased by a factor of 10 over the Hägglund modification.

Viscose rayon in a hot, strongly alkaline solution is extremely sensitive to air oxidation. In the Enka copper number method, cellulosic degradation by oxygen trapped within and between the fibers is prevented by soaking for 15 min. in a sodium sulphite solution before it is heated with the alkaline citrate solution.

ENKA COPPER NUMBER PROCEDURE

Reagents

1. Copper sulphate, 60 g. $CuSO_4 \cdot 5H_2O$ per liter.
2. Sodium citrate, 250 g. citric acid·H_2O + 183 g. NaOH made up to 1 liter.
3. Alkaline copper citrate, 200 ml. (2) + 50 ml. (*1*).
4. EDTA, 0.02 *N*, 4.0 g. disodium salt per liter.

Standardize with standard copper solution using PAMA indicator and 25 ml. sodium acetate buffer, pH 5.8.

5. Sodium acetate buffer, 200 g. sodium acetate per liter. Add acetic acid to pH 5.8 (about 8.5 ml. glacial HAc per liter).

Table I. Auto-oxidation of Reagents on Heating

Reagent	*Time in boiling water bath, hr.*	*Cu_2O formed (calc. as copper no.) assuming 1 g. sample*
Hägglund copper tartrate	0.5	0.534
	1.0	1.44
	1.5	2.11
	2.0	3.05
Enka copper citrate	1.0	0.0
	1.5	0.0
	2.0	0.0

6. PAMA indicator, 0.05 g. in 100 ml. ethanol (available from Eastman Kodak Co. by the name 2-(*p*-dimethyl amino phenol azo) pyridine).
7. Sodium sulphite, 4%, 4 g. per 100 ml.
8. Nitric acid, 100 ml. conc. HNO_3 per 500 ml.

Preparation of Sample

The only special apparatus required is a Wiley mill or similar type of grinder for preparing a finely divided sample. To assure a homogeneous sample, it is advisable to mix the ground sample thoroughly with water, filter, and air-dry.

Procedure

1. To a finely divided 0.500 to 0.700-g. sample (weighed to nearest milligram) in a 70-ml. test tube, add 10 ml. 4% Na_2SO_3 and let stand 15 min. Use of a stirring rod to insure complete wetting and elimination of large air bubbles is convenient. The stirring rod may be left in the tube during the entire boiling period. (*Caution:* the hot mixture must not be stirred.)
2. Add 25 ml. alkaline copper citrate and let stand 15 min.
3. Place in a boiling water bath of sufficient volume to immerse the tube 1 to 2 in. above the level of copper citrate. An inverted, water-filled volumetric flask can be used for keeping the water level constant.
4. After 1 hr., filter through a fine, sintered glass crucible and rinse the sample quantitatively onto the filter with about 50 ml. distilled water.
5. Wash 3 times with 20-ml. portions of acetate buffer, stirring thoroughly for about 1 min. between each washing. Addition of a small amount of distilled water to the buffer just before filtering helps in the removal of copper(II).
6. Wash thoroughly with 150 to 200 ml. distilled water to remove the last traces of copper(II) and discard the filtrate.
7. Place filter on clean 500-ml. suction flask and add 25 ml. hot HNO_3 solution. It is convenient to heat the nitric acid by placing it in a test tube in the water bath at the time the filtering is started.
8. After about 1 to 2 min., filter and wash with 100–150 ml. distilled water.

Table II. Effect of Varying Sample Weight

Sample	*Weight, g.*	*Enka copper no.*
Rayon	0.50	1.15
	1.03	1.18, 1.20
	1.53	1.22
Pulp	0.31	1.20
	0.60	1.21
	1.04	1.18

Table III. Stability of Copper Citrate Solution

Date of analysis	*Age of solution, days*	*Enka copper no. of viscose rayon, sample 2*
Oct. 6, 1958	0	1.69, 1.69, 1.67
Oct. 16, 1958	10	1.65, 1.68
Nov. 5, 1958	30	1.71, 1.73, 1.75
Dec. 5, 1958	60	1.81, 1.77
Jan. 14, 1959	100	1.77, 1.80
Jan. 14, 1959	0	1.67, 1.68

9. Neutralize the HNO_3 with 20% NaOH. The solution will develop a bluish tinge on neutralization.
10. Add 10 or 12 drops of PAMA. (The solution should be yellow. If not, add more NaOH.) Add glacial acetic acid dropwise until an intense purple color first appears. Excess acetic acid will result in an indistinct red end point.
11. Add 25 ml. acetate buffer and titrate with 0.02 *N* EDTA to an orange-yellow end point. Copper number = $(3.18 \times \text{ml. EDTA} \times N)/W$, where N = normality of EDTA and W = dry weight of the sample.

EVALUATION OF THE ENKA COPPER NUMBER METHOD

Comparisons of blank determinations on the Hägglund copper tartrate and Enka copper citrate methods are shown in Table I. These data indicate that there is no auto-oxidation in the copper citrate reagent on heating.

Twenty milliliters of an almost saturated solution of sodium citrate containing 4% free NaOH will complex 5 ml. of copper sulphate solution during a 1-hr. or more heating period. Addition of more copper results in the immediate precipitation of copper(II) hydroxide with the formation of insoluble CuO on heating. Less copper results in a slightly low copper number.

Variation of the ratio of copper(II) to free NaOH showed that as the per cent free NaOH increases the copper number decreases. This is true not only

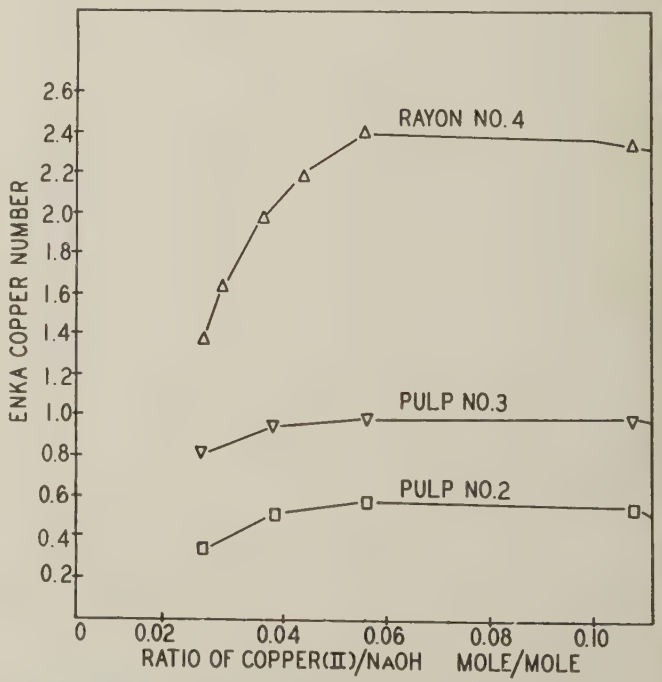

Fig. 1. Effect of copper(II)/NaOH in alkaline citrate on copper number

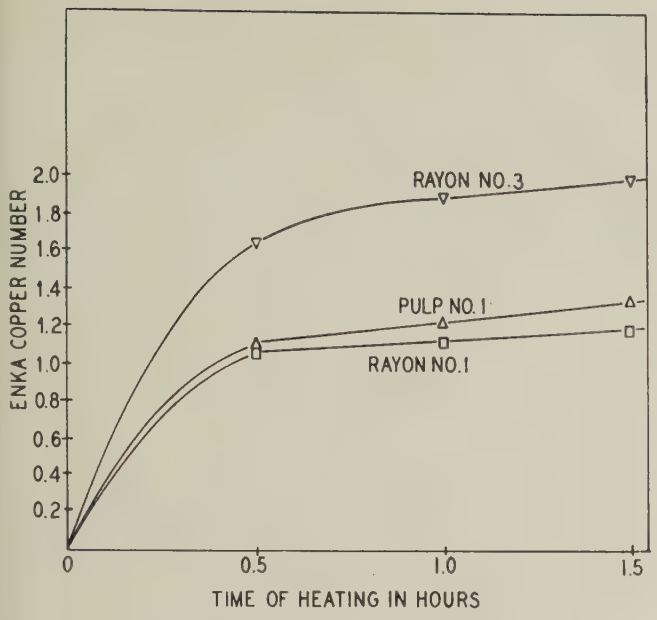

Fig. 2. Effect of varying heating time

for rayon but for pulps and cotton as well. The reagent alkaline copper citrate as used in a method contains 0.06 mole copper(II) per mole of free NaOH. Note that the variation in copper number for the two pulp samples shown in Fig. 1 lies within or almost within the 0.2 reproducibility for the Hägglund method. The mechanism of this phenomenon is far from understood. Perhaps it is connected in some way with the alkali sensitivity of the cellulose.

Figure 2 shows the effect of varying the heating time.

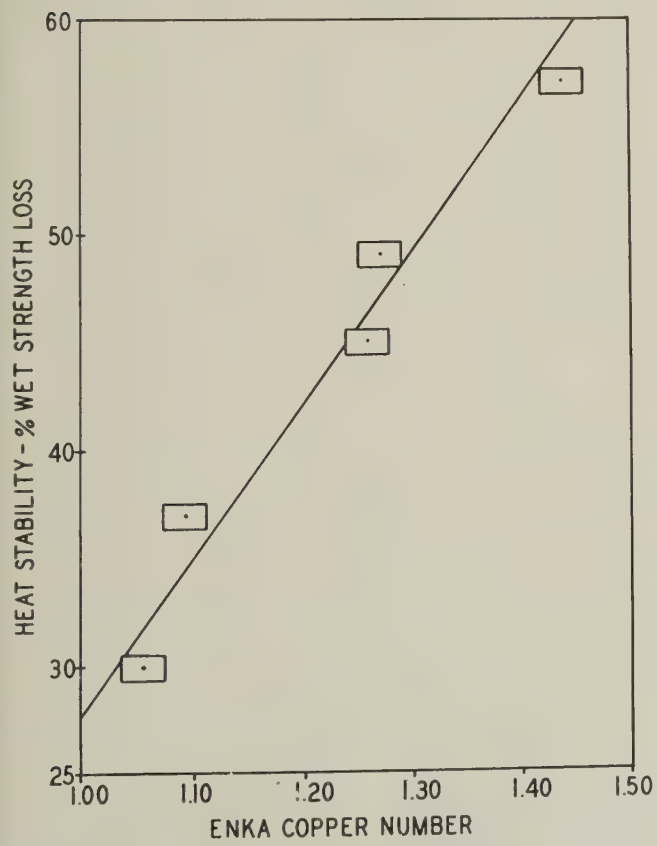

Fig. 3. Relationship of Enka copper number to heat stability

Table IV. Precision of the Enka Copper No. Method

	Enka copper no.				
Rayon no. 1	*Rayon no. 2*	*Rayon no. 3*	*Pulp no. 1*	*Pulp no. 2*	*Cotton*
1.16	1.62	1.90	1.12	0.59	0.07
1.13	1.69	1.90	1.12	0.60	0.10
1.17	1.69	1.92	1.12	0.57	0.09
1.13	1.67	1.85	1.22	0.70	...
1.15	1.65	1.93	1.27	0.61	...
1.14	1.68	...	...	...	...
1.15 ± 0.01[a]	1.67 ± 0.02	1.90 ± 0.02	1.17 ± 0.06	0.61 ± 0.03	0.09 ± 0.01

[a] Average deviation of a single measurement = $\Sigma d/n$.

These data indicate that 30 min. heating time is insufficient for most samples. The rayon heated for 1.5 hr. shows only about 0.1 higher copper number than 1 hr., so 1 hr. was chosen as a sufficient and practical heating time for rayon cellulose. The data for the pulp sample are not quite as satisfactory. Before using this procedure extensively for pulp determinations, even longer heating times should be investigated. This is probably related to the accessibility of the cellulose. With this method, variation in the sample weight from 0.5 to 1.5 g. is possible with little effect on the copper number (Table II).

Table V. Comparison of Enka and Hägglund Copper No. Results on a Viscose Rayon Sample

Hägglund	*Enka*
1.2	1.90
0.9	1.90
1.2	1.92
1.4	1.90
1.3	1.93
1.3	1.85
1.2 ± 0.1	1.90 ± 0.02

An added convenience of the method is that the copper(II) and the alkaline complexing agent can be kept as one solution. The stability of the copper citrate is sufficient for ordinary work over a period of 3 mo. (Table III). For very reproducible work, however, the two should be mixed freshly every 10 days.

Table IV shows the precision or average deviation of a single determination for viscose rayon to be ±0.02 copper number which is a considerable improvement over the precision of ±0.1 copper number of present methods. For pulp it does not seem to be quite as precise. Copper numbers determined using the Enka procedure give somewhat higher results than the Hägglund method, as shown in Table V and, therefore, cannot be directly compared, just as the Hägglund method does not give the same results as the TAPPI Standard.

APPLICATION OF THE ENKA METHOD

Rayon samples were bleached by sodium hypo-

Table VI. Copper No. and Color Reversion of Rayon

Bleach scheme no.	*Lower temperature drying*		*Higher temperature drying*	
	Copper no.	*Whiteness rating*	*Copper no.*	*Whiteness rating*
1	1.12	2	1.36	5
2	1.00	1	1.08	2
3	1.14	3	1.14	3
4	1.02	2	1.06	2
5	1.23	2	1.21	2

chlorite or acidified sodium chlorite, or hydrogen peroxide and combinations thereof. The tendency to yellow upon drying or heating was determined to be related to the type of bleach used, and for samples with the same bleach history the tendency to yellow is directly related to small changes in copper number. Illustrative data are shown in Table VI wherein sample whiteness is rated on an arbitrary scale of 1 to 5 by visual observations. A higher number signifies greater color reversion.

Heat stability of rayons with the same bleach history is inversely related to the copper number. Such a relationship is illustrated by Fig. 3. Enka copper number is plotted against the per cent wet strength loss suffered by samples upon being steamed for 4 hr. at 120°C. Note that the heat stability varied from 30–57% wet strength loss whereas the copper number varied only from 1.05 to 1.44. Such a relationship could not have been easily detected by a less precise copper number method.

CONCLUSIONS

1. A new (Enka) method for determining the reducing groups in cellulose has been developed featuring stable solutions, no blanks and a precision (for rayon) of ±0.02 copper number.

2. Because of its greater precision, the Enka method is adequate for elucidating relationships between small changes in copper number, heat stability, and reversion of rayon cellulose.

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Periodate Oxystarches in Paper Application*

EDWARD J. JONES, BETTE WABERS, JOHN W. SWANSON, C. L. MEHLTRETTER, and F. R. SENT

A series of periodate-oxidized cornstarches, ranging from 0.10 to 96% conversion to dialdehyde chain products, and a selected group of oxystarches from other grain starches have been evaluated for papermaking applications. The oxystarches of higher degree of reaction (above about 60% oxidation) were found to have desirable low viscosity and high paper reinforcing strength properties. These materials performed very satisfactorily as tub-sizing agents. In addition, the tub-sized papers were found to possess excellent wet strength. The oxystarches, under the conditions of application, were unsatisfactory as beater adhesives because of very low retention in the paper. Likewise, paper coatings prepared with the low viscosity, high oxidation level oxystarches as adhesives had relatively low pick strength, apparently due to excessive migration of the adhesive into the base paper. The desirable dry and wet-strength properties found in surface-sizing application and the expectation that the difficulties encountered in beater addition and coating adhesive applications can be overcome, provide a basis for recommending further development work with the periodate oxystarches.

The periodate oxidation of anhydroglucose polymers such as cellulose and starch to yield, under controlled conditions, the C_2–C_3 dialdehyde chain product is a well-known reaction (*1*). Several years ago, the United States Department of Agriculture, Northern Utilization Research and Development Division found an economical way to make dialdehyde starch, also called periodate oxystarch (*2*) and the product is now commercially available. A number of possible industrial uses were made worthy of evaluation as a result of this development. These include tanning of leather, paper applications, thickening agents and plasticizers, and organic raw materials source (*3*). The Department of Agriculture in *1956* contracted with The Institute of Paper Chemistry to evaluate a range of representative periodate oxystarches for applications in the paper industry. This paper constitutes a status report on this evaluation.

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After this work was essentially completed a paper by Alexander Meller on the wet strength properties of paper prepared with oxidized starches appeared in *Tappi* 40: 684 (1958).

* This research was done by The Institute o Paper Chemistry, Appleton, Wis., under contract with the U. S. Department of Agriculture and authorized by the Research and Marketing Act of 1946. The contract was supervised by the Northern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture, Peoria, Ill.

PERIODATE OXYSTARCHES USED

The predominant portion of work in this program was done with cornstarch that had been converted to the dialdehyde form by the Northern Utilization laboratory to yield a range of oxidation levels. The oxidation level varied from 0.01 to 96%. Representative oxystarch samples produced from other starches were included. These were 91% oxidized wheat starch, 93% oxidized waxy cornstarch, and 95% oxidized high amylose cornstarch.

The periodate oxystarches were found to be difficult to disperse, with prolonged heating in water at 95°C. producing only partial dispersion. Two treatments were developed to overcome this limitation. Approximately 1.8% borax ($Na_2B_4O_7 \cdot 10H_2O$) based on dry oxystarch, when dissolved in the water prior to addition to oxystarch, was a minimum amount of alkali required to effect complete dispersion. Larger quantities of borax were avoided because of known degradation action of alkali on the oxystarch. The oxystarches are themselves somewhat acidic, so that pH rapidly fell to a level of 4.0 to 5.0 when the oxystarch-borax suspension was heated. No appreciable inflection in viscosity was observed during the course of dispersion with borax. For the samples of high oxidation levels, final viscosities were quite low, even up to 60% solids. The second

dispersing treatment was accomplished with sodium bisulphite. It was found that 15% $NaHSO_3$, based on the dry oxystarch, was adequate to yield complete dispersion and low viscosity. In this case, when the oxystarch suspension was heated in the sodium bisulphite solution, it invariably went through an early state of setting to a stiff gel in the range of 50 to 85°C. This gel broke after a few minutes of continued heating to yield the low-viscosity dispersion.

PAPERMAKING APPLICATIONS

The periodate oxystarch preparations were evaluated as fiber deflocculating agents, beater adhesives, coating adhesives, and surface-sizing agents.

DEFLOCCULATING AGENTS

In an effort to find the property of ropiness or pituitiveness commonly associated with deflocculating agents, experiments in this area were limited to the higher viscosity, more mildly treated, periodate oxystarches (up to 35.8% oxidation) partically dispersed in hot water. One, three, and five per cent additions were made to manila pulp. No improvement in uniformity of formation was secured under these conditions.

BEATER ADHESIVES

The full range of periodate oxystarches were tried as beater additives, incorporated in a softwood bleached sulphite pulp and a blend of 75% hardwood bleached kraft–25% softwood bleached sulphite pulps. The furnishes were prepared with and without rosin-alum sizing. The oxystarches were incorporated as dry powders, water dispersions, and sodium bisulphite dispersions. The pulps were lightly beaten to approximately 700 ml. S. R. freeness. Handsheets were prepared without white water recirculation.

In dry addition, high retention was achieved, but the oxystarches tended to behave as inert fillers producing a decrease in sheet strength. When the oxystarches were dispersed before addition to the pulp, as with sodium bisulphite, very poor retention was secured and consequently little significant strengthening effect was realized. Retention of the oxystarches was measured by a modification of the carbohydrate-Zerban method (*4*) and was found to decrease with increasing level of oxidation.

As will be brought out later in this paper, the periodate oxystarches do possess an unusual potential strengthening effect for paper. To realize this benefit in beater-addition applications, it will be necessary to devise methods of holding the oxystarches in the fiber mat.

COATING ADHESIVES

Periodate oxystarches ranging in degree of oxidation from 0.01 to 96% were evaluated as adhesives in paper-coating formulations. All oxystarches tested in this phase of work were dispersed in solutions of borax or sodium bisulphite. The coating formulations were prepared in a manner which enabled evaluation of the effect of the dispersing agent, total solids content, adhesive-to-clay ratio, and calendering. Each formulation contained coating clay, a dispersing agent (sodium tetraphosphate), distilled water, and a given periodate oxystarch. Hand drawdowns were made using a Mayer rod on coating-grade paper, to give a coating weight of approximately 15 lb. per ream. Properties of the formulations and of the coated paper were compared to those secured with a representative commercial hypochlorite-oxidized starch used as a coating adhesive.

Highly desirable low-viscosity properties were imparted to the coating formulations by the more highly oxidized oxystarches (above 60% oxidation). Optical properties of the coated sheets appeared to be satisfactory. The strength values attained, however, were low in relation to the adhesive-to-clay ratio. Experiments in the area of surface sizing indicated that the oxystarches possess a higher inherent strength than was evidenced in coating results. Strength values were considerably higher when migration into the substrate was prevented by coating carefully cleaned aluminum foil. The methods explored for minimizing migration into the coating stock proved unsatisfactory. The potential does exist for developing an efficient coating adhesive based on the periodate oxystarches if further chemical modification of the oxystarches or innovations in coating formulations are successful in overcoming the problem of migration into the base paper.

SURFACE SIZING FOR DRY AND WET STRENGTH

The inherent strength characteristics of the periodate oxystarches were fully realized when they were employed as surface-sizing agents. With the problems of migration or poor retention eliminated, and with the advantage of their very low viscosity characteristics, the periodate oxystarches were demonstrated to be capable of yielding high-strength tub-sized papers. An unanticipated property of the periodate oxystarches disclosed in the evaluation was their capacity for imparting excellent wet strength to the sized paper.

The findings with respect to surface sizing are set forth in some detail in the following paragraphs.

Periodate oxystarches ranging from 11.7 to 96% oxidation were included in the study of surface-sizing properties. The oxystarches of very low degree of oxidation were omitted due to the high-viscosity characteristics of the dispersions.

Dispersions of the oxystarches were prepared using borax or sodium bisulphite as described earlier. When it was necessary to disperse small quantities of oxystarch for tub sizing (usually less than 20 g.), dispersion was accomplished by slowly adding the dry oxystarch to a mechanically stirred solution of the dispersing agent. The suspension was then heated on a steam bath with continuous stirring to 95°C. and held at this temperature for specified periods of a few minutes to one hour before it was allowed to cool. When larger quantities of the oxystarches were desired, dispersions were prepared in the one-liter Corn Industries viscometer which provides a more precisely controlled heating and cooling cycle generally similar to that describeda bove.

The oxystarch dispersions were stored overnight, when necessary, at 40°F. No changes in the dispersion or treated paper related to storage time up to 24 hr. were detected.

For comparison with the oxystarches, dispersions of a hypochlorite-oxidized cornstarch, commonly used commercially as a tub-sizing agent, were employed.

Table I. Physical Data for Sheets Tub-Sized with Periodate-Oxidized Cornstarch, 5% Dispersions

Item no.	Cornstarch	Starch uptake, %	Basis weight, 17 × 22—500	Thickness, mils	Burst, pt./100 lb.	Tensile strength, lb./in. In	Tensile strength, lb./in. Across	M.I.T. fold In	M.I.T. fold Across	G.E. brightness, %
1	Control	None	18.4	3.8	157	25.1	12.7	120	53	75.7
2	H-O cornstarch[a]	2.4	19.3	4.0	202	28.8	14.7	259	100	74.5
3	H-O cornstarch	2.3	19.6	4.0	192	29.2	14.4	308	86	...
	Dispersions Prepared with 15% Sodium Bisulphite									
4	11.7% Oxidized	3.0	19.4	4.0	211	29.0	14.7	239	85	75.4
5	35.8% Oxidized	1.8	19.4	4.0	176	28.6	14.3	207	88	75.1
6	63.7% Oxidized	3.6	19.4	4.0	192	29.6	15.3	302	114	75.2
7	90% Oxidized	2.7	20.1	4.0	195	30.5	16.1	454	197	...
8	95.3% Oxidized	2.4	19.0	4.0	220	31.3	15.7	375	139	74.5
9	96% Oxidized	2 2	19.8	4.1	206	31.7	16.5	488	158	...
	Dispersions Prepared with 1.8% Borax									
10	90% Oxidized	2.5	19.7	4.0	190	29.3	14.8	369	99	...
11	96% Oxidized	2.1	19.9	4.1	177	29.3	14.9	267	111	...
12	96% Oxidized	2.3	19.6	4.1	200	30.8	15.4	359	117	...

[a] Hypochlorite-oxidized cornstarch.

The dispersions were prepared by cooking 15 to 30 min. at 95°C. using one of the two methods described for the oxystarches.

All of the tub sizing was done on a hand-operated size unit, using slack-sized 100% rag stock as the base paper. The temperature of the dispersions was kept between 50 and 55°C. during sizing. Unless otherwise specified, the treated papers were air dried.

The following physical tests were performed on the sized sheets: basis weight, bursting strength (Mullen), tensile strength, tear (Elmendorf), folding endurance (M.I.T.), and brightness according to TAPPI standard methods, and were used to interpret the effectiveness of the periodate oxystarches as tube-sizing agents.

The more significant physical properties of the treated papers are summarized in Tables I and II.

Items 4 through 9 in Table I indicate the high strength exhibited by the bisulphite-dispersed oxystarches and that the strength of the tub-sized sheets increases with increasing level of oxidation of the starch. Borax-dispersed oxystarches yielded high-strength paper, as will be seen by items 10 through 12, but on the whole the results were not quite so favorable as were those with the bisulphite dispersions.

Table II summarizes data for papers tub sized with borax and sodium bisulphite dispersions of periodate-oxidized waxy corn, high amylose corn, and wheat starch. The bisulphite dispersions of these materials yielded some of the highest strength results obtained in the evaluation, as will be seen particularly by items 7 through 12.

When an evaluation of the wet-strength potential of the oxystarches was undertaken, consideration was given to the fact that the degree of wet strength secured from an adhesive having this potential is generally associated with the level of gain of dry strength. Little dry-strength increase has so far been secured from incorporation of the oxystarches as beater additives, due to the very low retention by the fiber. In the work on tub sizing, it has been found that the dry-strength gain is a function of increasing degree of oxidation. For these reasons, the evaluation experiments on wet strength reported herein have been limited to paper tub sized with the higher oxidation level products.

The test method employed has been based on TAPPI Standard T 456 m-49. This standard requires that tensile tests be run on strips immersed in water for periods of time until a stable minimum strength value is obtained, and this equilibrium value reported as the wet-tensile strength. To supply a more informative picture and because of the uncertainty of determination of this type of equilibrium, we have elected to show the change in wet-tensile strength with time in table and graphic form. The results secured in wet-strength testing are subject to strong variables, some of which are discussed and illustrated in the reference cited in Table IV.

Table II. Physical Data for Sheets Tub-Sized with Periodate-Oxidized Wheat, Waxy Corn, and High Amylose Cornstarches

Item no.	Starch used	Starch concn., %	Starch uptake, %	Basis weight, 17 × 22—500	Thickness, mils	Burst, pt./100 lb.	Tensile strength, lb./in. In	Tensile strength, lb./in. Across	M.I.T. fold In	M.I.T. fold Across	G.E. brightness, %
1	93% Oxidized waxy corn	5	2.2	20.0	4.1	175	28.0	13.3	275	104	72.6
2	93% Oxidized waxy corn	10	4.6	20.7	4.1	173	29.0	14.9	210	130	70.8
3	95% Oxidized high amylose corn	5	2.3	20.4	4.1	163	28.2	13.9	193	99	72.6
4	95% Oxidized high amylose corn	10	4.7	20.6	4.2	165	30.0	14.8	152	106	71.0
5	91% Oxidized wheat	5	2.4	20.1	4.1	173	28.5	13.5	289	75	72.1
6	91% Oxidized wheat	10	5.1	20.7	4.2	168	26.6	14.8	256	125	69.3
7	93% Oxidized waxy corn	5	2.0	20.0	4.0	207	29.5	16.2	433	178	74.3
8	93% Oxidized waxy corn	10	4.0	20.5	4.0	213	32.0	17.1	523	227	73.6
9	95% Oxidized high amylose corn	5	2.1	19.9	4.0	222	31.4	16.6	341	219	74.1
10	95% Oxidized high amylose corn	10	4.1	20.3	4.0	232	32.5	18.0	484	220	73.8
11	91% Oxidized wheat	5	2.3	20.3	4.0	236	33.3	17.9	604	308	73.7
12	91% Oxidized wheat	10	4.8	20.7	4.0	250	34.2	19.3	777	326	72.5

Items 1–6 contained 1.8% borax based on the weight of the starch. Cooked 30 min. at 90 to 95°C.
Items 7–12 contained 15% $NaHSO_3$, based on the weight of the starch. Cooked 13 min. at 80 to 85°C. and 17 min. at 90 to 95°C.

The first test of wet-strength potential was secured by selecting high dry-strength samples from the series on tub sizing, covering both borax-dispersed and bisulphite-dispersed oxystarches. These, along with the control untreated paper and the reference paper treated with commercial hypochlorite-oxidized starch, comprise the products included in Table II. The results secured and tabulated in this table demonstrate that the strength. To answer this, and to secure data on a second sample of oxystarch, the papers represented by items 6 through 8 and items 11 and 12 of Table III were prepared. As indicated, drying conditions were varied in these sets to bring out any thermal effect and all of the samples were subjected to wet-strength tests within a few days after production (up to 3 weeks). Comparison with results for the year-old air-dried

Table III. Wet-Tensile Strength of Rag Papers Tub-Sized with Periodate-Oxidized Starches

Item no.	Treatment	Concentration size bath, %	Uptake of size, %	Schopper tensile in machine direction, lb./in.							Wet strength, % Wet tensile treated paper / Dry tensile treated paper × 100					
				Dry	Wet 5 min. soaking	Wet 30 min. soaking	Wet 60 min. soaking	Wet 4 hr. soaking	Wet 8 hr. soaking	Wet 16 hr. soaking	5 min. soaking	30 min. soaking	60 min. soaking	4 hr. soaking	8 hr. soaking	16 hr. soaking
1	Untreated paper	..	..	25.1	4.0	4.0	3.9	..	..	..	15.9	15.9	15.5	..	..	..
2	Untreated paper	..	..	27.0	4.1	3.9	3.7	..	..	..	15.2	14.5	13.7	..	..	..
3	H-O cornstarch[a]	5	2.4	29.5	3.8	3.2	3.2	..	..	..	12.9	10.9	10.9	..	..	..
4	90% Oxidized cornstarch, borax cook	5	2.5	29.3	11.0	7.9	6.8	4.4	3.5	3.8	37.5	27.0	23.2	15.0	11.9	13.0
5	96% Oxidized cornstarch, borax cook	5	2.3	30.8	13.4	10.6	8.8	6.3	5.5	4.7	43.6	34.5	28.6	20.5	17.9	15.3
6	96% Oxidized cornstarch, borax cook, air dried	5	2.6	30.5	12.1	11.0	8.8	5.6	4.7	4.6	39.7	36.1	28.9	18.4	15.4	15.1
7	96% Oxidized cornstarch, borax cook, short steam dry	5	2.6	25.5	14.6	9.2	9.3	5.3	4.6	4.5	57.2	36.1	36.5	20.8	18.0	17.7
8	96% Oxidized cornstarch, borax cook, 5 min. steam dry	5	2.6	26.7	12.0	10.6	8.7	6.5	5.2	4.8	45.0	39.7	32.6	24.4	19.5	18.0
9	90% Oxidized cornstarch, bisulphite cook	5	2.7	30.5	12.8	11.5	9 8	6.8	5.8	4.7	42.0	37.7	32.1	22.3	19.0	15.4
10	96% Oxidized cornstarch, bisulphite cook	10	4.9	33.0	17.3	16.6	14.7	9.6	7.7	5.8	52.9	50.8	45.0	29.4	23.6	17.8
11	96% Oxidized cornstarch, bisulphite cook, air dried	5	2.2	30.3	10.8	9.4	8.4	6.6	5.8	4.8	35.6	31.0	27.7	21.8	19.1	15.9
12	96% Oxidized cornstarch, bisulphite cook, 5 min. steam dry	5	2.2	29.3	11.0	9.5	8.7	8.3	5.5	5.5	37.5	32.4	29 7	28.3	18.8	18.8
13	1:1 ratio of (a) Peter Cooper TG220 glue containing 0.2% alum and (b) 96% oxidized cornstarch containing 1.8% borax. Air dried	5	3.0	31.2	9.0	8.0	6.9	5.8	5.7	5.5	28.9	25.7	22.1	18.6	18.3	17.7
14	93% Oxidized waxy cornstarch, borax cook	5	2.2	28.0	8.1	5.8	5.0	3.7	3.6	3.6	28.9	20.7	17.9	13.2	12.9	12.9
15	95% Oxidized high amylose cornstarch, borax cook	5	2.3	28.2	7.9	6.3	4.8	3.7	3.4	3.5	28.0	22.4	17.0	13.1	12.1	12.4
16	91% Oxidized wheat starch, borax cook	5	2.4	28.5	9.0	6.5	4.7	3.8	3.4	3.4	31.6	22.8	16.5	13.4	11.9	11.9
17	93% Oxidized waxy cornstarch, bisulphite cook	5	2.0	29.5	14.1	12.1	10.1	7.5	5.6	5.0	47.8	41.0	34.2	25.4	19.0	17.0
18	95% High amylose cornstarch, bisulphite cook	5	2.1	31.4	16.1	12.1	11.3	8.5	6.9	5.6	51.4	38.6	36.0	27.1	22.0	17.9
19	91% Oxidized wheat starch, bisulphite cook	5	2.3	33.3	17.7	14.8	14.0	10.7	7.8	7.2	53.1	44.4	42.0	32.1	23.4	21.6

[a] H-O is hypochlorite-oxidized cornstarch.

oxystarch-treated papers have significantly high wet-tensile strength.

These papers are prepared by tub sizing a slack-sized rag paper with the indicated oxystarch at 50°C. Except where otherwise noted, the sized papers were air-dried and tested at 73°F. and 50% R.H. Some of the papers had been stored for 10 to 12 months before securing wet-strength tests. A question requiring answer was, therefore, the influence of time and temperature on the development of the observed wet samples described above reveals no significant differences, either as an increase or loss of the property with time.

The one direct comparison of different levels of oxidation, 96% oxidation in item 5, as against 90% oxidation in item 4, shows higher wet strength for the higher oxidation level. Confirmation and establishment of the significance of this would require additional experimental work.

Tests were run on papers tub sized with mixtures of

Table. IV. Wet-Tensile Strength of Wood Pulp Paper Beater-Sized With Synthetic Resins

Item no.	Treatment	Resin added, basis dry fiber, %	Schopper tensile, lb./in. Dry	Schopper tensile, lb./in. Wet 5 min. soaking	Schopper tensile, lb./in. Wet 4 hr. soaking	Schopper tensile, lb./in. Wet 8 hr. soaking	Schopper tensile, lb./in. Wet 16 hr. soaking	Wet tensile treated paper × 100 / Dry tensile treated paper 5 min. soaking	4 hr. soaking	8 hr. soaking	16 hr. soaking
0	Control, none	0	21.1	1.1	1.1	...	1.0	5.2	5.2	...	4.7
2	Control, rosin and alum	0	18.8	1.5	1.5	...	1.5	8.0	8.0	...	8.0
3	As Item 2, plus melamine-formaldehyde resin	2	19.7	5.8	5.8	...	6.0	29.5	29.5	...	30.5
4	As Item 3	3	21.0	7.7	7.6	7.0	7.6	36.7	36.2	33.3	36.2
5	Paper treated with cationic urea-formaldehyde resin[a]	3	...	12	10	...	9	...	...	...	...

[a] Maxwell, C. S., *Tappi* 35: 220–3 (1952).

animal glue and oxystarch primarily to determine whether the aldehyde groups of the starch would act as insolubilizing agents for the glue to enhance the wet strength of the product. A representative combination, condition, and wet-strength result secured is given under item 13 in Table III. The wet strength secured was at least as good as that for the straight oxystarches, indicating that a worth-while interaction is probably being achieved. Rapid gelling of the treating solutions encountered when preparing this particular combination was avoided in other experiments by omission of the aluminum sulphate, with no loss of desirable properties.

The three special oxystarches identified in the early part of this paper and described with respect to dry-strength properties are covered in regard to their wet-strength application under items 14 through 19 of Table III. In line with dry properties, the wet strength of the periodate-oxidized wheat starch dispersed with bisulphite is outstanding. Whether this difference is basic or represents some unidentified change in processing or testing conditions cannot be answered at present.

The melamine-formaldehyde resin-treated paper used for reference was made in our laboratory to permit direct comparison under the same test conditions. American Cyanamid Co.'s Parez No. 607 resin was employed. Data from the literature are unsatisfactory for direct reference because of the wide variation in testing conditions and type of data reported. The entries for item 5 of Table IV are the best published reference data that we could find, but the absence of dry-strength data makes this of limited value.

In Fig. 1, the results for the best of the periodate starches cooked with bisulphite, 91% oxidized wheat starch, and the best of those cooked with borax, 96% oxidized cornstarch, are shown in comparison with

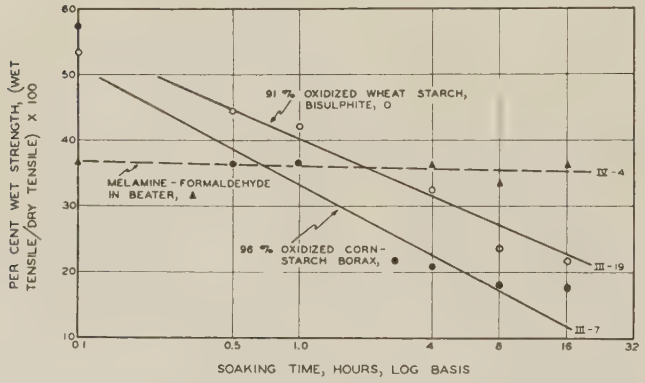

Fig. 1. Per cent wet tensile strength rag papers tub sized with periodate oxidized starches

results for handsheets made in the laboratory from wood pulp to which 3% melamine-formaldehyde resin (Parez 607) was added along with rosin and alum before forming. The figure illustrates the most general conclusions so far developed. The periodate-oxidized starches consistently produce excellent wet strengths when used as tub-sizing agents for paper. Up to several hours of soaking time, these wet strengths are as good or better than those secured by addition of comparable quantities of synthetic resins to paper stock before formation. Papers treated with periodate-oxidized starches consistently show a continuing decline in wet strength with time of soaking in contract to the lower rate of change of the synthetic resin-treated papers. It is felt that the excellent wet-strength retention of the oxystarch-treated papers through the first few hours of soaking would amply satisfy most use requirements.

CONCLUSIONS

The periodate oxystarches of high degree of oxidation. have been shown to possess a highly attractive combination of properties. Very low dispersion viscosity is combined with excellent dry- and wet-strength properties as shown in the reported work on surface-sizing applications. No adverse properties for this use other than sensitivity to alkaline dispersing agents and temporary gelling with sodium bisulphite have been found. If provision can be made to cope with these conditions, consideration of commerical surface-sizing applications should be warranted.

From a technical standpoint, several areas for further work are apparent. A clarification of the low viscosity-high strength property in terms of the structural properties of the dialdehyde-substituted chains would yield valuable fundamental information. A basic investigation of the electrical potential properties of the oxystarches should yield an understanding of the reasons for low retention in beater addition and migration from coatings. This understanding might be expected to produce methods for overcoming these limitations and making possible the production of wet-strength papers by beater addition and water-resistant coatings using the periodate oxystarches.

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Oxidation of Resin Acids in Wood Chips

RAY V. LAWRENCE

There is a considerable difference in the composition of the resin acids extracted from pine wood chips and in the resin acid portion of pine oleoresin. Much of this difference is caused by the oxidation of the resin acids as they are exposed over the large surface area of the wood chips. The oxidation of the acids in the chips was quite rapid and in a few hours the levopimaric acid content was approximately one-half that of pine oleoresin. When the surface area was decreased by extracting small blocks of wood instead of chips the concentration of the oxidized acids was greatly decreased. A study of the oxidation of some of the pure resin acids was carried out. Pure levopimaric acid was usually resistant to oxidation, but in the presence of light and a sensitizer it was rapidly oxidized. Several products were isolated and characterized from the oxidation of the pure acids. The conditions favoring the formation of some of these products were determined. About 20% of the acids extracted from wood chips had been oxidized to some extent. Approximately the same amount of oxidized resin acids were present in black liquor soap.

THERE is considerable difference in the composition of tall oil rosin and gum rosin. There are several factors that contribute to this difference. Both products originate in the oleoresin of the pine tree and it is well known that the components of this oleoresin are sensitive to both heat and oxidation. The higher temperatures and longer processing times required for the tall oil rosin account for some of this difference but a major factor involved is the oxidation of the resin acids in the wood chips before the processing starts.

Gum turpentine and rosin are prepared from pine oleoresin by distilling the turpentine from the oleoresin, leaving the rosin as the residue in the still. In removing the turpentine, the rosin is exposed to a temperature of 150°C. for about 30 min. It may be stored at 130–140°C. for longer periods for handling and packaging. The oleoresin is obtained by periodically wounding a pine tree and allowing the oleoresin to collect in a cup attached to the tree. The principal acids in pine oleoresin are shown in Fig. 1.

Presumably, the oleoresin inside the resin ducts of the tree has the same composition that it has immediately after it exudes from the tree. Samples of oleoresin have been examined a few minutes after it exuded from the tree and there was little difference between its composition and the composition of commercial oleoresin several weeks after it came out of the tree. Levopimaric acid is the major constituent of pine oleoresin. It comprises from 20 to 35% of the acid portion of all of the pine oleoresins investigated. When this acid is heated or treated with a mineral acid it is converted into a mixture of three other acids: neoabietic acid, palustric acid, and abietic acid (*1*, *2*). The neoabietic and palustric acids are further isomerized by acids and heat to give abietic acid. When a mixture of these acids is heated for long periods, the final product contains about 95% abietic and 2 to 3% each of palustric and neoabietic acid. Under certain conditions, oxidation can bring about the same sort of isomerization. During the processing of pine oleoresin to gum rosin, thermal isomerization occurs to the extent that practically all of the levopimaric acid is isomerized and there is in the rosin approximately equal amounts (about 18% each) of palustric, neoabietic, and abietic acid. Of course, the isomerization continues if the heating of the rosin is continued. This thermal isomerization occurs only in the presence of acid. When the sodium salt of rosin is heated, very little change takes place until the temperature becomes high enough to decompose the resin acids (*3*). Another change that occurs with more drastic heating of resin acids is the loss of two hydrogen atoms from the abietic acid to yield dehydroabietic acid (*4*).

Levopimaric is more readily isomerized by heat and acids than any of the other resin acids in the oleoresin. Thus the levopimaric acid content of an oleoresin is a good measure of the heating and oxidation that the oleoresin has undergone. Since the levopimaric, neoabietic, and palustric acid are all isomerized to abietic acid on prolonged heating, the abietic acid content of an oleoresin or rosin is also a good indication of how much heating these products have had.

Since most of the tall oil processing up until the time the black liquor soap is separated occurs in an alkaline medium, the resin acids should go through this without too much isomerization. Because of the tendency of the resin acids to isomerize in the presence

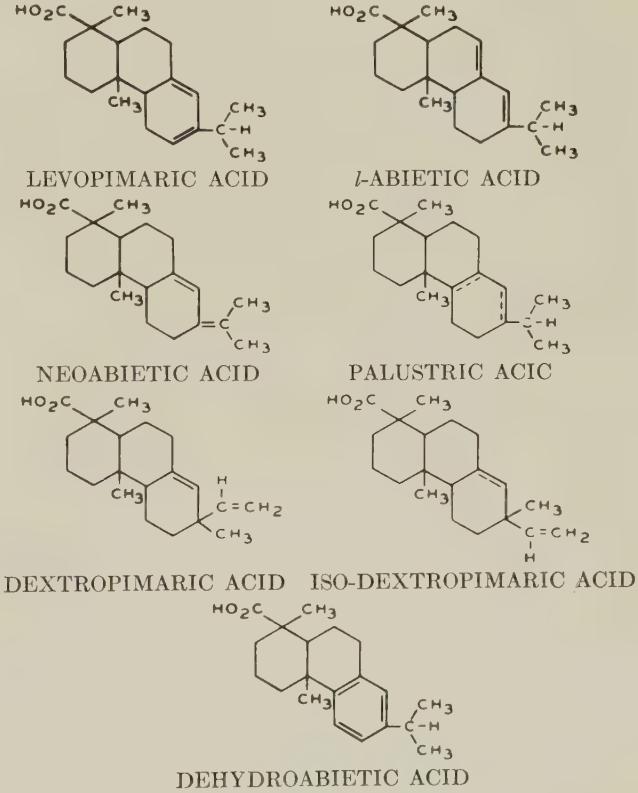

Fig. 1 Structures of the resin acids

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of mineral acid, the step of acidifying the black liquor soap to form crude tall oil might be expected to cause a major change in the composition of the resin acid fraction. However, so much isomerization has already occurred by this time that there is not a very great change at this point. All of the levopimaric acid and most of the palustric and neoabietic acid are either oxidized or isomerized by the time the black liquor soap is separated.

Baldwin, *et al.* (*5*), determined the resin acid composition of a variety of naval stores products including black liquor soap, tall oil rosin, and the acids extracted from pine chips.

In processing the black liquor soap to tall oil rosin the oxidized resin acids disappeared and there was a corresponding increase in the amount of dehydroabietic acid present. Apparently the oxidized acids were converted to dehydroabietic acid during the processing. In order to determine how and where the oxidized acids were formed, a sample of wood chips was extracted with isooctane and the composition of the resin acids determined chromatographically.

The chromatographic scheme used (*6*) was a modification of the Ramsey-Patterson method (*7*) originally developed for separating the higher fatty acids. This scheme separates the resin acids into six major groups. Information on the products separated is given in Table I (*5*). The sixth group consists of the stronger acids present and the oxidized acids are found in this group. Although the chips were exposed to the air only a few hours, the levopimaric acid content was only 14%, and 21% of the acids present was oxidized enough to be brought over into the sixth group of the chromatographic scheme used. By the use of larger particles of wood, there was some increase in levopimaric acid; and when small blocks of wood (2 by 3 in.) were extracted, very soon after cutting, the levopimaric content of the extracted acids was 19%. The samples of resin acids from the blocks of wood had only 11% oxidized material present compared with 21% oxidized material from the chips and more than 25% from the black liquor soap acids. The oxidized acids from the black liquor soap and those from extracted wood chips were separated and compared. The oxidized acids from both sources were similar and the major constituents were formed from levopimaric acid or other abietic-type acids. The ultraviolet and infrared spectra of the oxidized acids indicated that hydroxyabietic and hydroxyneoabietic acids were both present. These acids appeared to have been formed quite rapidly from levopimaric acid when the pine chips were exposed to air.

In order to obtain these oxidized acids in a reasonably pure state, an attempt was made to prepare them from pure levopimaric acid. A sample of levopimaric acid was dissolved in alcohol and the alcohol solution allowed to evaporate from a piece of filter paper. This was done in order to give a large surface area for the oxidation of the levopimaric acid. The pure levopimaric acid on the filter paper showed no tendency to oxidize even on several days' exposure to light and air in the laboratory. Solutions of levopimaric acid in turpentine and isooctane were also stable to oxidation when allowed to evaporate from filter paper; but when a few milliliters of the isooctane extract of pinewood was added to the filter paper, the levopimaric acid was completely converted into isomerization and oxidation products in a few hours.

Table I. Chromatographic and Ultraviolet Absorption Data on Intermediates of Sulphate Process

Group	*Resin acids from slash pinewood*		*Resin acids from black liquor soap*	*Tall oil rosin*
1, %	1[a]	1[b]	0	6[c]
2, %	18	10	9	10
$[\alpha]_D$	+52°	+74°	+73°	+51°
α at 266 mu	20.4	24.7	28.8	21.6
3, %	41	57	49	52
$[\alpha]_D$	−91°	−68°	−66°	−68°
α at 242 mu	22.5	15.2	27.5	55.9
α at 272 mu	5.2	7.7	...	...
4, %	14	19	12	7
$[\alpha]_D$	+126°	+93°	+116°	...
α at 251 mu	77.4	67.6	69.2	21.8
5, %	3	2	6	20
$[\alpha]_D$	+47°	...	+47°	+56°
α at 284–286 mu	1.6	...	1.4	0.8
α at 276 mu	4.2	4.5	4.5	2.7
α at 268 mu	...	...	4.9	2.8
α at 252 mu	7.5	7.6	5.3	2.2
α at 242 mu	7.2	6.6	5.0	2.1
6, %	21	11	25	4
$[\alpha]_D$	−8°	...	−12°	...
α at 242 mu	27.9	...	31.5	...
α at 250 mu	26.9	...	26.5	...

[a] Wood shaved before extraction.
[b] 2 by 3-in. chunks of wood extracted under N_2 blanket.
[c] Eluted in four peaks between 0 and 250 ml.

Further studies have been made on the oxidation of levopimaric acid and other resin acids. The greatly increased rate of oxidation of the levopimaric acid in the presence of the pinewood extract indicated that some of the oxidation probably occurred by a photosensitized method. When an alcohol solution of levopimaric acid containing a small amount of a sensitizing dye was irradiated with visible light and blown with oxygen or air, it was converted into a peroxide (*8*). The photoperoxide formed in this way from levopimaric acid was a transannular peroxide which was rapidly rearranged in alkaline solution to give an unsaturated hydroxy ketone (*9*). In addition to the several dyes that were effective sensitizers, some of the simpler compounds such as orthoquinones were also effective. The reaction forming the peroxides gave very few side reactions in dilute solutions but when the concentration of acids was as great as 5 to 6%, several side reactions took place and dehydroabietic acid was one of the products formed. This reaction could also account for the presence of some of the dehydroabietic acid present.

Table I gives some information on the composition of the resin acids present in tall oil rosin, those from black liquor soap and the resin acids extracted from slash pinewood. The black liquor soap was very carefully acidified with dilute acetic acid in order to avoid any additional isomerization. The resin acids were removed from the fatty acids present by precipitation as their cyclohexylamine salts. The cyclohexylamine salts were converted to the free resin acids and these acids separated by the chromatographic method mentioned earlier.

Table II. Distribution of Abietic-Type Acids in Gum and Tall Oil Naval Stores Products

	Palustric, %	*Levo-pimaric, %*	*Abietic, %*	*Neo-abietic, %*	*Dehydro-abietic, %*
Oleoresin	10	24	10	12	3
Gum rosin	17	0	20	17	5
Slash pine chips	11	14	14	11	3
Black liquor soap	7	0	27	9	6
Tall oil rosin	7	0	39	4	17

Twenty-five per cent of the resin acids separated from the black liquor soap were oxidized sufficiently to require benzene to remove them from the column. The ultraviolet and infrared spectra of the oxidized resin acids from the black liquor soap and those from the slash pinewood indicated that they were quite similar in composition. All of the oxidized acids were lost when the acidified black liquor soap was distilled to give the tall oil rosin. Further isomerization of the palustric and neoabietic acid to abietic acid also took place during the fractional distillation step.

Table II gives a comparison of the resin acid composition of several naval stores products. The tall oil rosin contained 39% abietic acid and the black liquor soap only contained 27% of this acid. The dehydroabietic acid content also increased between these processing steps. Apparently some of the hydroxy acids that had been formed by oxidation were dehydrated to give dehydroabietic acid which accounted for about 17% of the resin acids in the tall oil rosin. It accounted for only 6% of the black liquor soap and less than 3% of the resin acids from slash pinewood. One interesting item on this composition table is the fact that these five acids made up approximately 50% of the slash pinewood and black liquor soap resin acids, while in the case of the tall oil rosin these five acids account for about 67%. This increase in the abietic-type acids presumably came about through the concentration of these acids in the more volatile portion of the tall oil rosin when it was distilled. They are further increased by the loss, into the tall oil pitch, of the easily polymerized materials and nonvolatile products present in the crude tall oil.

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Self-Heating of Wood Fiber

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Wood fiberboards, made from ten species of hardwoods and softwoods, were tested for benzene-alcohol extractable content and for rate of self-heating. Self-heating is defined as the increase in temperature of a material above the temperature of its surroundings owing to an exothermal reaction occurring within the material. The self-heating rate was determined by heating a cubical sample of fiberboard to 325°F. in a specially constructed furnace. As the temperature of the fiberboard increased because of self-heating, the temperature in the furnace was maintained 0.5°F. below that of the fiberboard to contain most of the generated heat within the sample. The extractable content of the wood fiber was determined according to TAPPI Standard T 6 m-54, with a few minor changes. The results disclosed that the alcohol-benzene extractable portion of the wood was apparently responsible for the exothermic reaction, and the rate of reaction increased linearly with the amount of extractable material. Two correlations were found, one for hardwoods and northern softwoods, and one for southern softwood.

THE phenomenon of self-heating of wood fiberboard was brought into sharp focus with the burning of one carload of this material while in transit and the destruction by fire of an additional eight carloads and the warehouse in which it was stored (*1*).

One of the first explanations of the cause of self-heating was presented by Kollman (*2*) who found that heat was developed in dry wood cells when they absorbed moisture. However, Holmgren (*2*) calculated that this heat would not be sufficient to ignite the wood fiber. He did suggest the possibility of some other exothermic reaction which would begin in the last phase of the drying process and continue if the boards were not cooled sufficiently. He also concluded that wood fiberboards which were slightly dampened after drying had greater susceptibility toward self-heating than completely dry boards.

Bergstrom (*3*) presented the theory that the heat was generated by fungus and bacterial action. He found five species of molds and ten of bacteria in a pile of wood that had self-heated. One investigator (*4*) found that the progressive thermal decomposition of lignin became strongly exothermic at 518°F. Another report (*5*) attributed self-heating to the thermal decomposition of cellulose, beginning at about 570°F.

During preliminary work, differences in the proclivity toward self-heating were noted among several species of wood. It is known that "the individuality of wood is more precisely associated with the extraneous components than with any other chemical feature" (*6*). Since the organic-solvent extractable portion of wood varies from approximately 1.4 to 8.0%, it could be the prime factor in controlling the rate of self-heating. This investigation was undertaken to study the effect of the extractable fraction of wood on the self-heating phenomenon.

The reaction rate, or self-heating tendency, of ten species of wood was experimentally determined, and the correlations between the reaction rate and the alcohol-benzene extractable content were good.

EXPERIMENTAL

Apparatus

The apparatus was designed after that of Robertson and Raskin (*7*). Their furnace was considered most satisfactory for use in measuring reaction rates of wood fiber because it precluded any effect due to differences in

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Fig. 1. Self-heating test equipment

size, shape, density, or thermal conductivity of the material under test. When a mass of wood fiber is held at constant temperature, it will self-heat and its temperature rise will depend upon the afore-mentioned properties of the mass. The use of a variable-temperature furnace eliminated the effect of these variables and produced time-temperature curves that were characteristic only of the material.

The incorporation of the provision for a null-point indicator to aid in keeping the sample and furnace temperatures within 0.5°F. made the performance of the tests relatively simple without the use of automatic controls. The furnace and related controls are shown in Fig. 1. The apparatus consisted of a cylindrical furnace within which the sample was placed, an air flowmeter, an indicating potentiometer, a galvanometer, a Variac to control the power input to the furnace, and a switchbox.

The furnace was constructed of materials of low heat capacity and high insulating value so that the temperature could be readily changed with a moderate power requirement. The furnace chamber was formed by an aluminum cylinder $6^5/_8$ in. in diameter by 11 in. high, surrounded by $3^1/_2$ in. of lime-silica insulation. The top was closed by a plug made of 2 in. of lime-silica insulation between pieces of $^1/_2$-in. rigid insulating board. A steel cylinder 5 in. high by 5 in. in diameter, was supported from the plug. This cylinder in which the sample was placed had $2^1/_2$-in. diameter openings at top and bottom to allow free circulation of air around

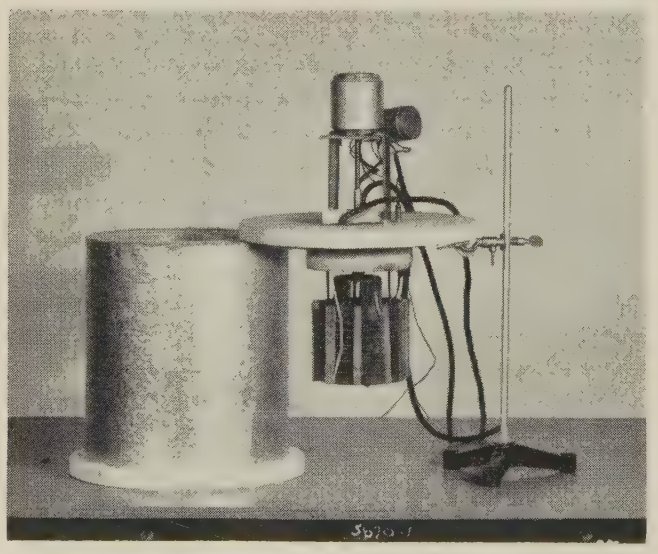

Fig. 2. Details of furnace

the sample. The air was circulated by a 3-in. diameter blower driven by an external motor. Heat was supplied by a nichrome winding mounted on insulating strips on the outside of the steel cylinder. Openings were provided in the closure plug for the passage of air into and out of the furnace and for leading the thermocouple wires into the furnace. Figure 2 shows some of the details of the furnace.

The flowmeter, used to measure the rate of air led into the furnace, was of the orifice type. It was calibrated by water displacement. Compressed air from the central laboratory system was used for all tests.

The switchbox contained an arrangement whereby each thermocouple could be read independently or the two thermocouples could be switched into a differential thermocouple. A light-beam galvanometer was used as a null-point indicator and, when switched into the differential thermocouple arrangement, signified that the two temperatures were equal when no current flowed through the galvanometer. This instrument was sufficiently sensitive to pick up a differential of 0.5°F. A Brown Electronik double range potentiometer was used to measure the temperatures.

Test Procedure

In conducting a self-heating test, the sample was placed in the steel cylinder with the furnace at room temperature. The sample was composed of sufficient layers of boards to make a cube 3 in. on edge. The bead of a chromel-alumel thermocouple was placed at the geometric center of the cube and the cube was held together by two clamps made of angles and bolts. A second thermocouple was so placed as to measure the temperature of the air in the furnace. The air rate was regulated and the temperature of the furnace raised to a preselected value. This temperature was attained in four minutes and was maintained until the temperature at the center of the cube attained the same temperature. Temperatures were recorded at suitable intervals, usually every four minutes unless the temperature changed rapidly.

When the temperature of the sample exceeded that of the furnace, the latter was increased at a rate to keep it approximately 0.5°F. below the sample temperature. This procedure precluded any undue influence by the furnace temperature on the sample temperature and contained most of the heat generated by the sample within itself.

Reaction Rate

The slope of the time-temperature curve, of the 10 to 15°F. section above the original furnace temperature, was taken as the indication of the self-heating property of the sample. The average specific heat for 20 species of wood commonly encountered is 0.325 cal. per g., with a range from 0.317 to 0.337 (*8*). Thus, the same weight of any specie of wood fiber will require practically the same amount of heat to raise its temperature the same number of degrees. Conversely, the temperature rise of a cube of wood fiber is directly proportional to the heat it has acquired. Since this heat is self-generated by the wood fiber, it indicates the amount of reaction which has occurred in the wood fiber. The portion of the curve used to determine the reaction rate was essentially linear.

Table I. Effect of Variables on Test Results

Sample	Original furnace temp., °F.	Air rate, cu.in./min.	Moisture content, % dry wt.	Reaction rate, °F./min.
1	350	41.5	0.0[a]	2.15
2	350	41.5	23.6[b]	1.83
3	350	41.5	0.0[c]	2.00
4	350	41.5	8.2	2.05
5	350	0.0	8.2	0.980
6	350	96.0	8.2	2.25
7	300	41.5	0.0[c]	0.250
8	325	41.5	0.0[c]	0.900
9	325	0.0	0.0[c]	0.500
10	325	200.0	0.0[c]	0.900
11	325	41.5	34.8[b]	0.506
12	325	41.5	8.4	0.743

[a] Dried over magnesium perchlorate for 35 days.
[b] Exposed to 100% humidity at 75°F. for 35 days.
[c] Dried for 24 hr. at 160°F.

Variables in Testing

Three samples made from one sheet of insulating board were tested for reproducibility at arbitrarily set conditions. The reaction rates for these samples were 2.0, 2.08, and 2.08°F. per min. The conditions were an original furnace temperature of 350°F. and an air rate of 41.5 cu. in. per min. The effect of original furnace temperature, air rate to furnace, and moisture content of the boards was also checked.

The results of these tests are presented in Table I. The choice of final conditions was an original furnace temperature of 325°F., an air rate of 41.5 cu. in. per min., and samples dried at 160°F. The 325°F. original furnace temperature was selected because the reaction rate it produced was rapid enough that the tests were not too lengthy but not so rapid as to obliterate differences. The air rate chosen was arbitrary, but any increase had little or no effect. Samples were to be dried at 160°F. for 24 hr., mainly to shorten the time required for a test.

Analytical Method

The extractable content of the wood fibers was determined according to TAPPI Standard T 6 m-54, with a few minor changes. The wood fiberboard was rubbed over a coarse rasp to reduce it to near fiber size. Duplicate 3-g. samples of air-dry fiber were extracted for 8 hr. in a Soxhlet extractor. The solvent used was composed of two parts by volume of chemically pure benzene and one part of "Proprietary Solvent," a denatured ethyl alcohol supplied by Fisher Scientific Co. The percentage of extractives was based on the moisture-free weight of the fiber.

Board Formation

Boards, from which samples were taken for this investigation, were from commercial production or made on an 8-ft. diameter Oliver forming machine or in a board former complying with TAPPI method T 1001 sm-51. The last method was used to make boards from small amounts of fiber which had been classified by screening, heated, or extracted with an organic solvent.

Classifying

Southern softwood groundwood pulp (35% solids) was put through a $^1/_2$-in. mesh screen and allowed to dry overnight at room temperature. This fiber was then classified by means of U. S. Standard Screen in a RoTap and five fractions collected, ranging from plus 20 to minus 100 mesh. It was found advantageous to rescreen the fractions, starting with coarse screens, to separate the fibers before they reached the final screen.

Four boards were made from the classified wood fibers. One board was made with plus 30 mesh fiber; a second, with 70% minus 30 plus 40 and 30% minus 40 plus 50-mesh fiber; a third, with 39% minus 50 plus 60, 46% minus 40 plus 50, and 15% minus 60 plus 100-mesh fiber; and a fourth, with minus 60-mesh fiber.

Heating

Southern softwood groundwood pulp was screened through a $^1/_2$-in. mesh screen and allowed to dry overnight at room temperature. Portions of the fiber were then dried at elevated temperatures by passing heated air through the fiber for 3 hr. The fiber was put into a section of 6-in. diameter metal pipe which was well insulated and the air, heated by electrical heaters, was passed upward through the fiber. The temperatures of the air used were 200, 300, and 400°F.

Extracting

Air-dried southern softwood pulp was extracted with a solution of two volumes of benzene and one volume of denatured ethyl alcohol. About 200 g. of wood pulp were put into a 4-l. beaker and 3 l. of solvent added. After 2 hr. of leaching, with intermittent stirring, the pulp and solvent were separated in a vacuum filter. The solvent was recovered by simple distillation and reused. The wood pulp was extracted five times in this manner and allowed to air-dry.

RESULTS AND DISCUSSION

Uniform Self-Heating

The possibility of a thermal gradient existing in the cubical sample as it self-heated was investigated. A thermal gradient might exist because the outside portion of the cube attained the temperature of the furnace before the central part, and this outer portion could conceivably self-heat and have a higher temperature than either the furnace or the center of the sample.

A sample of insulating board, dried at 160°F. was assembled with thermocouple beads placed 0.3 in. apart on a line starting at the center of the cube and terminating at the center of one side. The results showed that the entire cubical sample self-heated uniformly throughout. The temperatures at the five points in the sample and the furnace temperature converged at 325°F. and then rose together as the sample self-heated. Thus, a single thermocouple could indicate the temperature of the entire sample after it exceeded the original furnace temperature.

Effect of Extractable Content

Various Wood Species. The reaction rates determined from self-heating tests and the extractable contents of nine samples of insulating board made from different species of wood fiber (not including southern softwood) are given in Table II. A plot of these results is presented in Fig. 3. A regression line, using the method of least squares, was calculated and drawn for the nine points. The equation for the line was $y = 0.094x - 0.004$, where y is the reaction rate in °F. per min. and x is the alcohol-benzene extractable con-

Table II. Extractable Content and Reaction Rate of Various Wood Fibers

Fiber	*Extractable content, %*	*Reaction rate, °F./min.*
Poplar	3.39	0.340
Lodgepole pine	5.02	0.575
White fir	5.66	0.420
Douglas-fir	3.65	0.340
Ponderosa pine	7.03	0.707
Willow	1.79	0.278
Cottonwood	2.56	0.100
Mixed hardwoods	4.57	0.345
Newsprint	5.13	0.500

tent in per cent. The correlation coefficient was found to be 0.86.

The curve, in essentially passing through the origin, implied that the reaction was entirely due to material extractable with an alcohol-benzene solution. The reasonably high value for the correlation coefficient indicated that most of the change in reaction rate was due to the difference in extractable content.

Samples of five of the insulating boards were extracted with an alcohol-benzene solution and tested for self-heating. In every case, the reaction rate was substantially reduced.

Southern Softwood. The results of the testing of southern softwood pulp which had been treated in different ways are presented in Table III. The same results are plotted in Fig. 3. The regression line was calculated and its equation was $y = 0.159x + 0.101$. The correlation coefficient was found to be 0.76.

The various treatments of the southern softwood fiber influenced the reaction rate only by changing the extractable content. The component responsible for the exothermic reaction was shown to be relatively nonvolatile at the temperatures used for drying insulating board.

The data on the boards formed from fiber that had

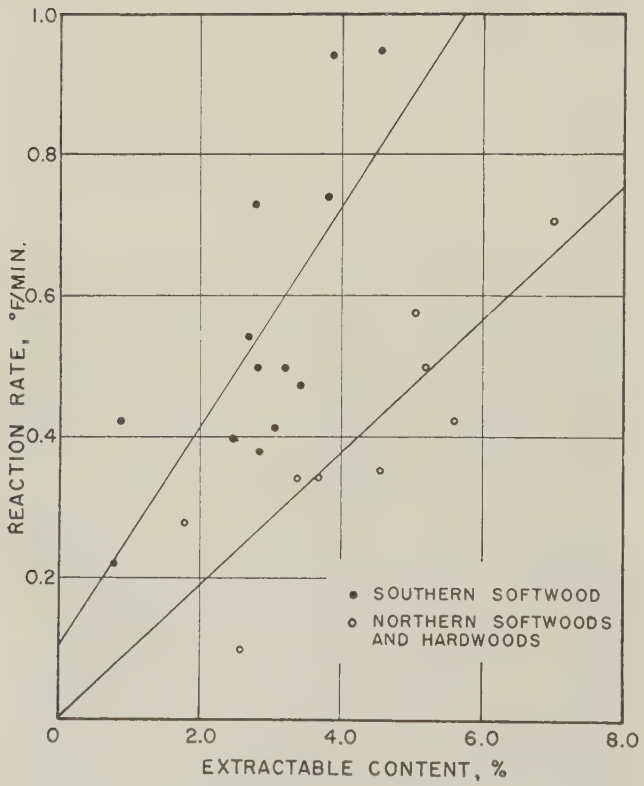

Fig. 3. Effect of extractable content on reaction rate

Table III. Extractable Content and Reaction Rate of Southern Softwood

Material	*Treatment*	*Extractable content, %*	*Reaction rate, °F./min.*
Fiber	Air dried at room temperature	3.17	0.508
	Dried with 200°F. air	2.84	0.500
	Dried with 300°F. air	2.47	0.398
	Dried with 400°F. air	3.08	0.411
	Dried with 400°F. air (check sample)	2.81	0.382
	Extracted with alcohol-benzene	0.79	0.217
	Screened—fine fraction	4.54	0.950
	Screened—med. fine fraction	2.79	0.731
	Screened—med. coarse fraction	2.65	0.540
	Screened—coarse fraction	3.45	0.482
Board	None	3.89	0.946
	Evacuated at 1.0 mm. Hg	3.80	0.740
	Extracted with alcohol-benzene	0.90	0.423

been classified by screening indicated that the size of fiber may be an important factor. The reaction rate decreased as the fiber size increased even though the extractable content did not follow the same pattern. This size effect is of small significance because the average size of fibers commonly used in the production of insulating boards does not vary significantly in comparison with the difference in size between the screened coarse and fine fibers.

The difference in the slopes of the curves correlating the reaction rate with extractable content of southern softwood and of other species may be due to the size effect. The fibers of fast-growing wood are shorter and relatively broader than fibers of slow-growing trees. The southern softwood trees are faster-growing than northern conifers or deciduous trees.

CONCLUSIONS

1. The self-heating of wood fiberboard appears to be due to an exothermic reaction of some component which is extractable with an alcohol-benzene solution.
2. The rate of self-heating of wood fiberboard is apparently controlled by the amount of such extractable material in the wood fiber.
3. The size of the fiber has an influence on the rate of the exothermic reaction.
4. The component of wood responsible for the exothermic reaction is relatively nonvolatile at either high temperature or low pressure.
5. Southern softwood fiber differs from northern softwood and deciduous fibers in self-heating properties.
6. The presence of moisture does not accelerate the exothermic reaction but rather extends the time required for attaining ignition temperature.

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This work is based on the thesis submitted in partial fulfillment for the M.S. degree in Chemical Engineering at Newark College of Engineering.

ASSOCIATION NEWS AND EVENTS

National Conferences

Thirteenth Alkaline Pulping Conference, Robert Meyer Hotel, Jacksonville, Fla., Nov. 4–6, 1959.

Forty-Fifth Annual Meeting, Hotel Commodore, New York, N. Y., Feb. 22–25, 1960.

Other 1959 Conferences

Oct. 26–28	Packaging Institute, Statler Hotel, New York, N. Y.
Nov. 9–10	National Paperboard Assoc., New York, N. Y.
Dec. 1–2	North American Pulp, Paper, and Paperboard Industrial Waste Conference, Edgewater Beach Hotel, Chicago, Ill.

Local Section Meetings

Pacific: Nov. 17, 1959, West Linn, Ore., "Coating and Printing"; Jan. 12, 1960, Longview, Wash., "Engineering"; April 15, 1960, Everett, Wash., Shibley Award Meeting; May 5–7, 1960, Bellingham, Wash., or Harrison Hot Springs, Annual Meeting; September, 1960, Salem, Ore., "Modernization."

Golden Gate District (Pacific Section): Plant visit to Dow Chemical Co., Dec. 1, 1959, "Economics of the Paper Industry"; Jan. 26, 1960, "Manufacturing and Marketing of Molded Paper Products"; March 29, 1960, "Recent Advances in Materials Handling"; May 17, 1960, R. M. True Memorial Lecture.

Delaware Valley: Oct. 22, 1959, Engineers Club, Philadelphia, Pa., "Felts"; Nov. 19, 1959, Engineers Club, Philadelphia, Pa., "Success in Safety"; Jan. 21, 1960, Engineers Club, Philadelphia, Pa., Operations Research Panel; Mar. 26, 1960, Benjamin Franklin Hotel, Philadelphia, Pa., 1960 Philadelphia Graphic Arts Conference; April 21, 1960, Engineers Club, Philadelphia, Pa., E. J. Albert Award Program; May 27, 1960, Beloit Eastern, Downingtown, Pa., tour and outing.

Kalamazoo Valley: Nov. 12, 1959, Inman's Restaurant, Galesburg, "Personal Development"; Dec. 3, 1959, Inman's Restaurant, Galesburg, "Coating"; Jan. 21, 1960, Harris Hotel, Kalamazoo, Papermakers' Get-Together; March 17, 1960, Inman's Restaurant, Galesburg, "Graphic Arts"; April 21, 1960, Inman's Restaurant, Galesburg, "Stock Preparation"; May 12, 1960, Harris Hotel, Kalamazoo, Recognition Night, WMU Awards; June 21, 1960, Annual Golf Outing, Gull Lake Country Club.

New England: Dec. 11, 1959, Past Chairmen's Night; April 8, 1960, Management Night; June 3–4, 1960, Chatham Bars Inn, Chatham, Mass., Spring Meeting.

New England (Eastern District): Armand's Restaurant, Route 9, Framingham, Mass.: Nov. 9, 1959; Jan. 11, 1960; March 14, 1960.

Ohio: Nov. 10, 1959, Manchester Hotel, Middletown, Ohio, "Atomic Power Plant Development." This is a joint meeting with the Superintendents Association. Speaker: Ed Pandorf of C. G. & E. Dec. 10, 1959, Manchester Hotel, Middletown, Ohio, "Mechanics of Retention." Jan. 12, 1960, Manchester Hotel, Middletown, Ohio, "Clupak." Speaker: C. A. Shoudy. Feb. 11, 1960, Colony Restaurant, Swifton Center, Cincinnati, Ohio, plant tour through Formica, a division of American Cyanamid. March 15, 1960, Manchester Hotel, Middletown, Ohio, "Two-phase Flow in a Wet Web." Speaker: Joe Parker, Beloit Iron Works. April 14, 1960, Miami University, Oxford, Ohio, a tour of the new Paper School. Subject: "High Polymers." Speaker: Herman Mark. May 12, 1960, Hartwell Country Club, Cincinnati, Ohio, Ladies' night.

Ohio (Indiana District): Marott Hotel, Indianapolis, Ind.: Oct. 20, 1959, Visit to R. R. Donnelly Plant, Crawfordsville, Ind.; Nov. 17, 1959; Dec. 15, 1959; Jan. 19, 1960; Feb. 16, 1960; March 15, 1960; April 19, 1960; May 17, 1960; June 21, 1960, Gulf outing.

Empire State (Metropolitan District): 465 Lexington Ave. New York, N. Y. Nov. 10, 1959, "What Happens at the Roll Nip"; Dec. 8, 1959, "Special Problems in the Use of Reclaimed Paper Fibers," *A Panel Discussion;* Jan. 12, 1960, "High Velocity Drying" (*Executive Night*); March 8, 1960, "Coating"; April 12, 1960, "Packaging"; May 13, 1960, Ladies Night.

Empire State (Northern District): Woodruff Hotel, Watertown, N. Y.

Empire State (Central District): University Club, 431 E. Fayette St., Syracuse, N. Y.

Empire State (Western District): Prospect House, Niagara Falls, N. Y.

Empire State (Eastern District): Queensbury Hotel, Glens Falls, N. Y. Nov. 19, 1959, "Fiber Behavior Studies" (Tentative); Dec. 17, 1959, "Dyes and Dyestuffs" (Panel); Jan. 21, 1960, Executives Night; Feb. 18, 1960, "Synthetic Fibers" (Tentative); Marcy 17, 1960, Junior Awards Contest; April 21, 1960, Symposium, "Wet End Machine Operation"; May 21, 1960, Annual Ladies Night.

Maine-New Hampshire: October 23–24, 1959, Lafayette Hotel, Portland, Me., Fall Meeting—"Stock Cleaning" June 17–18, 1960, Mountain View House, Whitefield, N. H., Annual Meeting.

Chicago: Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill.

Lake Erie: Nov. 19, 1959, Cleveland Engineering and Scientific Center, "Paper Requirements, Inks, Processing Advances and Problems of the Printing Industry"; Jan. 21, 1960, Cleveland Engineering and Scientific Center, Conference on Pulp and Paper Testing Equipment and Methods Including Laboratory Coating and Sheetmaking Techniques; Feb. 18, 1960, Colton Chemical Co., 6626 Union Ave., Cleveland, Ohio, plant tour; March 17, 1960, Cleveland Engineering and Scientific Center, "Off-Machine Coating with Emphasis on Waxing and Barrier Types and Base Paper Requirements."

Southeastern: Nov. 20–21, 1959, King and Prince Hotel, St. Simons Island, Ga. Jan. 22–23, 1960, Jacksonville, Fla.; March 18–19, 1960, Columbia, S. C.; May 20–21, 1960, Savannah, Ga.

Headquarters Office Re-Location

The TAPPI headquarters office will be moved sometime between October 15 and November 1 to a new building at 360 Lexington Ave., New York 17, N. Y.

James R. Lientz, TAPPI president, has announced the move which results from overcrowding at the present location. An intensive search for suitable locations both inside and outside of New York City was conducted over a four-month period. General agreement among the officers of the Association and the members of the headquarters staff was reached on this New York location as being appropriate for the

Association's type of operations and being adequate in size for present and anticipated needs.

The new office has a floor area of 6000 sq. ft. as compared to 3000 in the present one. The new quarters are on the 17th floor of the 360 Lexington building.

Members are requested to address all mail to 360 Lexington Ave. after October 15.

Agricultural Fibers Committee

The 1959 Spring Meeting of the Agricultural Fibers Committee met April 22–23 at the Consolidated Paper Co., Monroe, Mich. F. B. Greenwald (Consolidated), chairman, presided. Twenty-five members were present.

C. H. R. Johnson, president and general manager, Consolidated Paper Co., in welcoming the group to Monore commended the committee and the Northern Regional Laboratory (Peoria) for their respective contributions for improving product quality in the use of wheat straw for corrugating board. He observed that commercial use of straw for pulp in the United States had declined while consumption of pulpwood continued to increase. In this regard he was hopeful that the present research program of the Northern Laboratory might be sufficiently realistic so that the results could be used by the mills to increase use of straw. One of the greatest contributions to the containerboard industry, according to Mr. Johnson, was the development of the Concora medium test because that test now makes possible a realistic appraisal of the crush strength of corrugating media. He also issued a challenge for research to develop techniques to capitalize on the outstanding properties of straw.

The task committee report on continuous pulping of wheat straw was introduced by A. J. Sloan (Parsons and Whittemore) who described the production run for experimental pulp from wheat straw conducted in the Pandia pilot plant at Berlin, N. H., during March. This work was done under contract for the Northern Regional Laboratory at Peoria. Chopped straw was pulped for semicommercial scale production of 9-pt. corrugating board according to conditions established as satisfactory in a study of pulping variables conducted the previous October. Pulping was done with 6% caustic soda (basis dry straw) at 75 p.s.i. steam pressure with a dwell time of 8 min. and a liquid-solids ration of 4:1. Subsequent refining, screening, and converting of pulp to board was done at the New York State College of Forestry at Syracuse. Nine-point board was produced from 100% straw pulp and from a blend of straw pulp and repulped boxshop clippings. Mr. Sloan explained that a minor adjustment in clearance within the screw feeder of the Pandia unit permitted use of chopped straw preimpregnated with caustic soda solution for more effective distribution of the chemical with greater uniformity in quality of pulp than had been achieved before.

T. F. Clark, Northern Regional Laboratory, continued the discussion with presentation of pulp evaluation data acquired in the study of pulping variables and in the production runs. In the study of variables dwell time had ranged from 2.5 to 11 min., chemical concentration (caustic soda), from 4.2 to 8.3%, and steam pressures of 75 and 100 p.s.i.

Conclusions reached in these evaluations were the basis for selection of conditions used in the production run described by Mr. Sloan. Comparison of evaluation data for the continuous pulping run with similar type date from batchwise pulping of the same straw of the Northern Regional Laboratory indicated comparable or possibly more effective use of the straw and the pulping chemical by the continuous treatment.

Subsequent to the discussion of the results on pulping variables in continuous pulping of wheat straw and of results on the production runs to produce 100% straw corrugating and a blend, these materials were run through corrugating and combining operations in the boxshop of Consolidated Paper Co. Combined board was produced in 40-in. width in "A" and "C" flutes under normal operating conditions with commercial liners. Arrangements were made for fabrication of test boxes from the experimental board and from regular mill production. The test boxes and component materials were to be divided among the cooperating mills (Central Fibre Products Co., Quincy, Ill., Consolidated Paper Co., Monroe, Mich., and Weston Paper and Manufacturing Co., Terre Haute, Ind.) and the Northern Regional Laboratory for complete physical evaluation. The mills will furnish the test data to the Regional Laboratory where results will be consolidated and incorporated into a single over-all report oncontinuous pulping of wheat straw for production of corrugating board.

Mr. Clark also commented on further work of the laboratory in pulping wheat straw for corrugating by the cold soda process. Previous data given at the Columbus, Ohio, meeting (1958) concerned variables in the steeping of straw. The present comments covered re-use of refortified spent steep liquors. Results from 12 successive steeps showed that the increase in organic matter in spent liquors was progressively less with each succeeding steep. Similar results were observed for ash content of the liquors. Values for burst factor, breaking length, and crush resistance did not change appreciably after the initial steep.

Dr. I. A. Wolff, Chief, Industrial Crops Laboratory, Northern Utilization Research and Development Division, presented a brief account of the laboratory's program to screen new crops for oil, protein, and fiber content as means for selection of a crop having potential value as a new industrial raw material. He particularly reviewed for the group the specific program at the Northern Laboratory in seeking new annual pulp crops. He also reported unequivocally that research on agricultural residues at the Division would be discontinued at the end of this fiscal year (June 30, 1959).

In response to the inquiry of D. L. Miller (Northern Laboratory) regarding economic requirements of the industry it was disclosed that although straw currently costs the mills $14 to $18 per ton delivered the mills could accept any straw in competition with wood if the price of straw were lowered to $7 per ton. This was based on the availability of slab wood at about $6.50 per cord. This discussion led to consideration of factors influencing availability of straw to the mills. Actually it is the result of changing economic conditions; decreased wheat plantings in certain areas; the increasing practice of returning chopped straw with nitrogen to the soil; frequent wet periods during the normal harvest season; and subnormal winter conditions. Procurement of straw beyond a 100-mile radius of a mill tends to aggravate the uneconomic position of straws.

Some mill representatives felt that management in the strawboard industry had neglected to keep pace with changing economics and with competition by failing "to sell" straw corrugating. Straw corrugating was recognized as a quality product but the more aggressive merchandiser of corrugating from semichemical wood pulp has captured the corrugated container market. Claims were cited that the wood pulp sheets were easier to run than the straw sheets but this was not substantiated. On the contrary boxshop operators who were accustomed to running "split" media on corrugators favored the straw sheet.

Considerable discussion centered around the question of present and future status of the Agricultural Fibers Committee. Mr. Greenwald pointed out that in the last 10 years the number of mills producing 9-pt. straw corrugating had dropped from more than a dozen to about four or five. Mill participation in Committee affairs had dwindled proportionately. This situation, he felt, was a real problem which the committee had to face and a decision should be reached as to its future course. He suggested that the group might associate itself with some of the other groups having allied interests. A comment was made that in such an association straw processing might lose its identity by being overshadowed by the larger groups.

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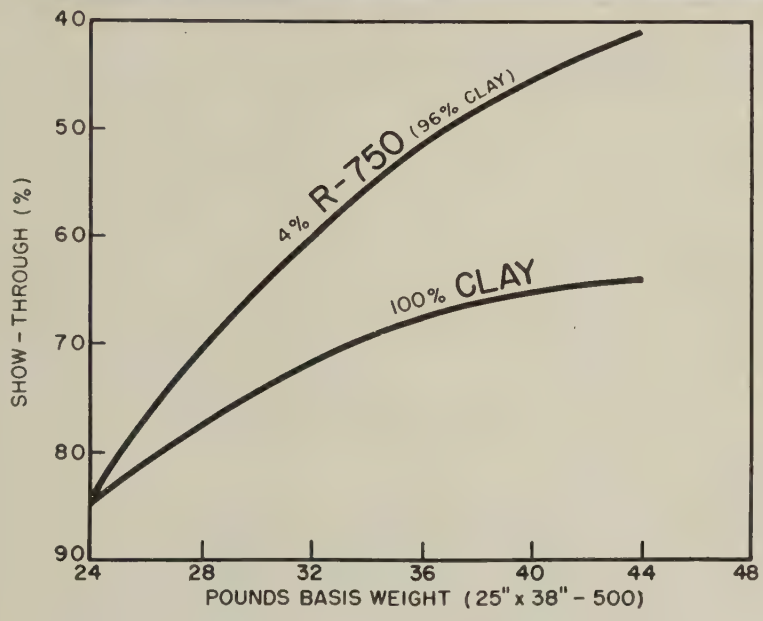

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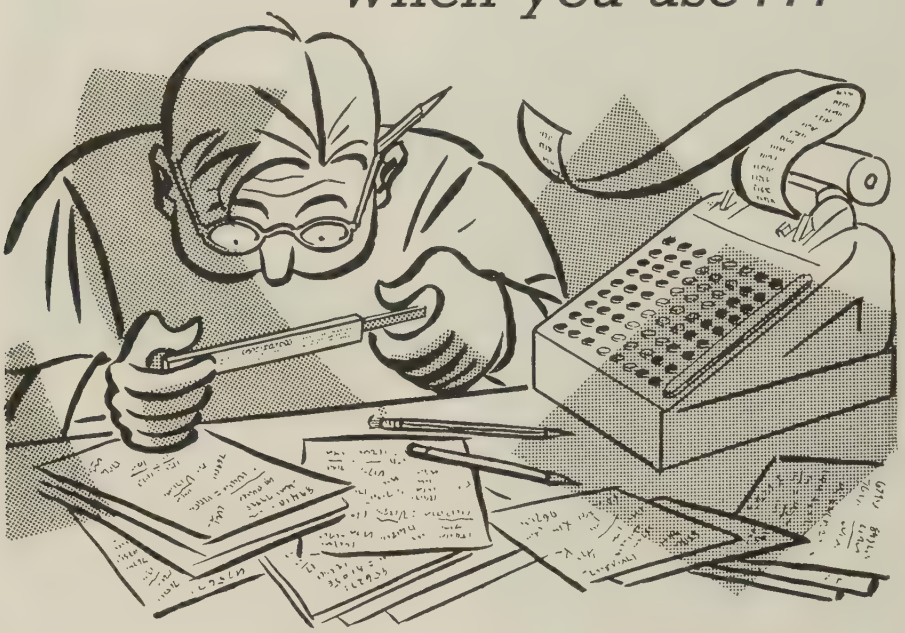

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According to T. F. Clark (Northern Laboratory) the Agricultural Fibers Committee (formerly Agricultural Residues Committee) was formed in the early 1940's because of the several problems common to the many mills and that these problems encompassed straw harvesting and procurement practices, preservation, and quality improvements. Later the committee changed its name as a means for avoiding any stigma that might be attached to the term "residues." Mr. Clark observed that with adoption of the new name the Committee indicated a broadening of interests and willingness to accept responsibility of greater scope. Attempts in the past to initiate programs of broader scope have met with some opposition. However, present difficulties associated with straw availability and procurement might stimulate consideration of other fibrous crops than straw or wood. There was general pessimism regarding the future of straw and that its use was disadvantageous because of the combination of climatic, agronomic, and economic factors as well as mistakes by management.

The members present agreed that to determine the future course of the committee, all past and present members should be canvassed for their current and future interest in the committee; and possibilities for affiliating with other groups should be explored. This study should be conducted so that results would be available for consideration at the October meeting to be held at the Northern Regional Laboratory in Peoria.

As an interesting sidelight of this meeting the Committee toured the facilities of the Enrico Fermi atomic power plant now under construction at Laguna Beach on Lake Erie a short distance outside of Monroe.

A social hour and dinner at the Monroe Golf and Country Club was sponsored through the courtesy of the Consolidated Paper Co.

T. F. Clark, *Secretary*

45th

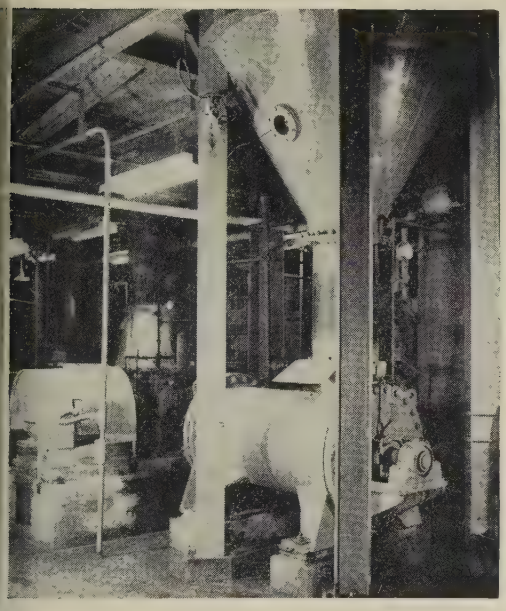
Annual Meeting

TAPPI

Hotel Commodore

New York, N. Y.

Feb. 22–25, 1960



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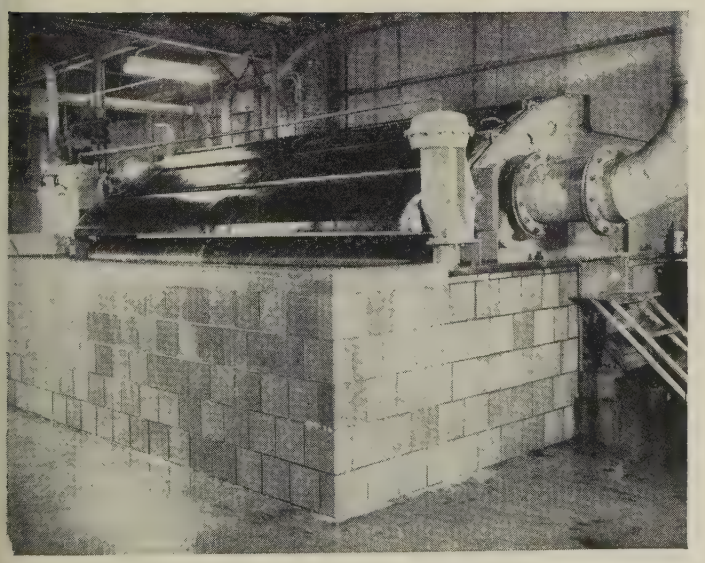

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New TAPPI Members

Harry D. Bauman, Senior Chemist, P. H. Glatfelter Co., Spring Grove, Pa., a 1934 graduate of Franklin and Marshall College.

Gerrit Boas, Sales Engineer, Black-Clawson (Canada) Ltd., Montreal, P. Q., Canada.

William H. Burgess, Jr., Project Engineer, West Virginia Pulp & Paper Co., Research Laboratory, Covington, Va., a 1954 graduate of Lehigh University.

Thomas W. Carroll, Chief Industrial Engineer, Owens-Illinois, Toledo, Ohio.

Ion Chivu, Technical Manager, Industria General Direction Pulp and Paper, Bucaresti, Roumania, a 1954 graduate of Technological Institute "MOLOTOV" Leningrad.

Robert D. Clarke, Market Manager, Paper Industry, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., a 1950 graduate of Georgia Institute of Technology.

Cecil H. Clinton, Technical Service Representative, Pennsylvania Industrial Chemical Corp., Clairton, Pa., a 1950 graduate of Thiel College.

Albert G. Cozza, Assistant Chief Chemist, Rayonier, Inc., Jesup, Ga., a 1937 graduate of the College of Puget Sound.

Vittorio del Prato, Cartiere di Ceprano e Atina, Naples, Italy, a graduate of Naples University.

Richard G. Elliott, Scientific Trainee, Wood Chemistry, Oregon Forest Products Laboratory, Corvallis, Ore., a 1959 graduate of Oregon State College.

John W. Feeley, Assistant Plant Engineer, New Haven Board & Carton Co., New Haven, Conn. Attended the University of Maine.

Robert W. Foster, Assistant to Executive Director, Paper Cup & Container Institute, Inc., New York, N. Y., a 1940 graduate of Swarthmore College.

William E. Fuller, Jr., Sales, Arnold, Hoffman Co., Providence, R. I. Attended the University of Alabama.

James W. Geiger, Staff Assistant to Vice-President in charge of Research, Philip Morris, Inc., Richmond, Va., a 1939 graduate of the University of Minnesota.

James L. Good, Research Engineer, West Virginia Pulp & Paper Co., Covington, Va., a 1958 graduate of the University of Maine.

Clarence L. Griffin, Jr., Application Engineer, Machinery Electrification, Inc., Northboro, Mass., a 1950 graduate of the University of the State of New York.

William E. Hall, Technical Representative, A. E. Staley Mfg. Co., Decatur, Ill., a 1955 graduate of the Texas Christian University.

John C. Hardy, Technical Sales Representative, Sandoz Australia Pty. Ltd., Sydney, N.S.W., Australia, a 1948 graduate of the University of Melbourne.

Thomas J. Hart, Research Engineer, The Champion Paper & Fibre Co., Hamilton, Ohio, a 1959 graduate of the University of Cincinnati.

Pieter Hiemstra, Chemist, AVEBE, Veendam, The Netherlands, a 1952 graduate of the University of Utrecht.

Herbert K. Holden, Supervisor, Hooker Chemical Corp., Niagara Falls, N. Y., a 1950 graduate of Rensselaer Polytechnic Institute.

George R. Huddleston, Jr., Research Laboratory Manager, Copolymer Rubber & Chemical Corp., Baton Rouge, La., a 1943 graduate of Mississippi State College.

Alvin E. Jerome, Salesman, The Borden Chemical Co., New York, N. Y., a 1958 graduate of Northeastern University.

Robert M. Jodrey, Project Engineer, Rice Barton Corp., Worcester, Mass., a 1949 graduate of Worcester Polytechnic Institute.

Robert L. Jones, Student, The Institute of Paper Chemistry, Appleton, Wis., a 1957 graduate of Rensselaer Polytechnic Institute.

Cleve R. Leckey, Senior Chemist, Oxford Paper Co., Rumford, Me., a 1957 graduate of the University of Maine.

Richard K. Lee, Vice-President, Alloy Rods Co., York, Pa., a 1935 graduate of Ohio State University.

Theodore B. Manheim, Product Manager, The Tanatex Chemical Corp., Kearney, N. J., a 1950 graduate of Philadelphia Textile Institute.

John B. Morton, Chief Chemist, Hercules Powder Co., Hopewell, Va., a 1937 graduate of Iowa State College.

Lawrence H. Muschamp, Chief Industrial Engineer, Donaldson Co., Inc., St. Paul, Minn.

Ernest P. Noble, Deputy Packaging Advisor, Unilever Ltd., London, England, a 1949 graduate of the University of London.

Ernesto Porras R., Chief, Cost Control and Statistics, Celulosa de Chihuahua, S. A., Anahuac, Chih., Mexico, a 1953 graduate of Institute of Technology, Monterrey.

Lewis C. Pounds, Assistant Group Leader, American Cyanamid Co., Wallingford, Conn., a 1948 graduate of Dartmouth College.

Kenneth W. Powers, Chemical Engineer, Project Leader, Esso Research & Engineering Co., Linden, N. J., a 1953 graduate of Cornell University.

Samuel I. Reames, Engineer, Hudson Pulp & Paper Corp., Palatka, Fla., a 1951 graduate of Georgia Institute of Technology.

Leon A. Rundbaken, Project Chemist, D. M. Bare Paper Co., Roaring Spring, Pa., a 1958 graduate of North Carolina State College.

Francis J. Scavitto, Research Chemist, Crown Chemical Corp., Providence, R. I., a 1955 graduate of Providence College.

Henry E. Schildt, Chief Chemist, Eaton Paper Corp., Pittsfield, Mass. Attended Pratt Institute.

Alfred J. Seaquist, Development Engineer, W. R. Grace & Co., Lima, Peru, a 1952 graduate of Pratt Institute.

John R. Seydel, Treasurer, Seydel-Woolley & Co., Atlanta, Ga. Attended the Georgia Institute of Technology.

Robert E. Smith, Manager, Vessel Sales, The Pfaudler Co. Div., Pfaudler Permutit, Inc., Rochester, N. Y., a 1933 graduate of Massachusetts Institute of Technology.

Carl Strutz, Analytical Chemist, Eastman Kodak Co., Rochester, N. Y., a 1955 graduate of the University of Rochester.

Liem Yoe Tjiang, Plant Manager, Pabrik Kertas "PADLARANG," Padalarang, Indonesia, a 1957 graduate of the Technical Faculty.

Richard N. Van Buren, District Representative, J. M. Huber Corp., New York, N. Y., a 1956 graduate of Western Michigan University.

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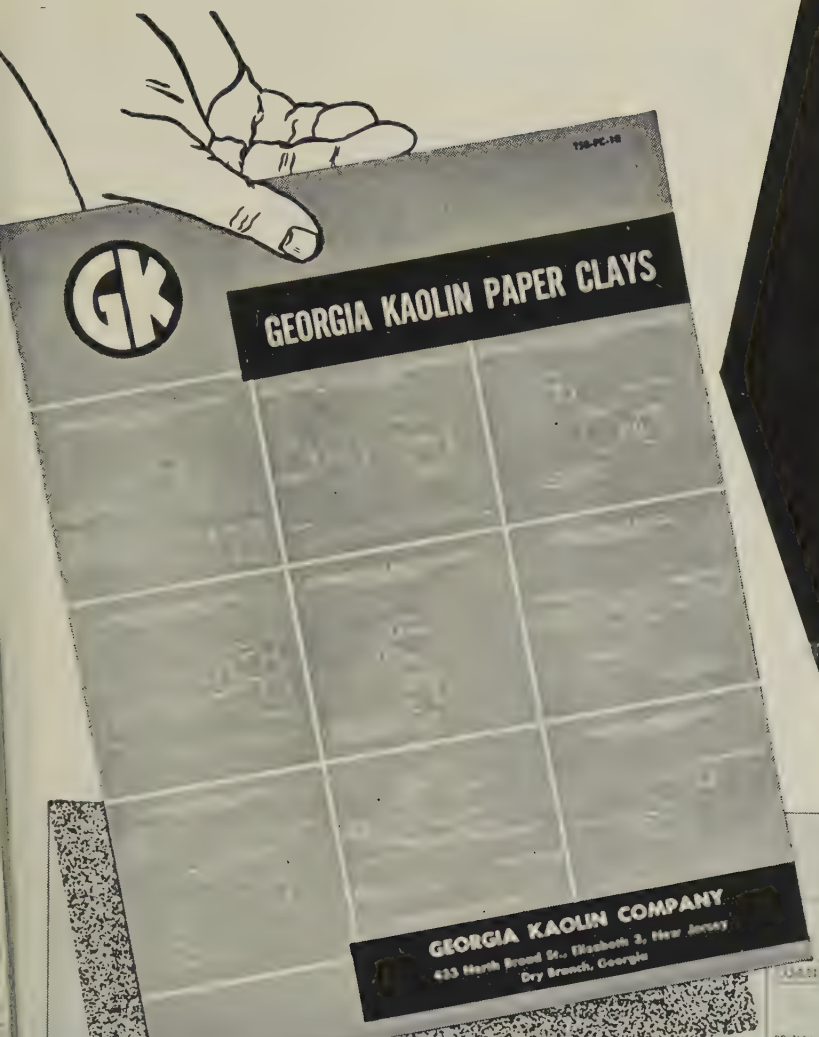

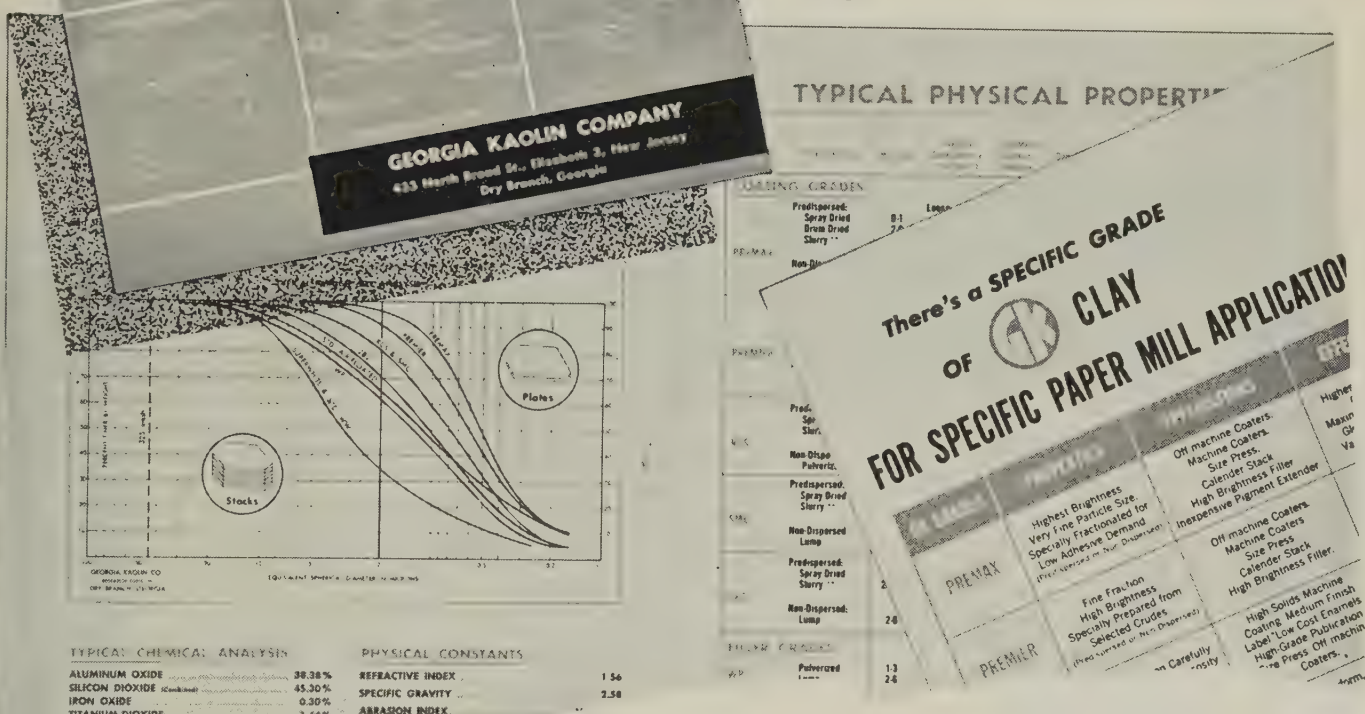

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William J. Waldie, Technical Manager, Sandoz Australia Pty. Ltd., Melbourne, Australia, a graduate of the Royal Melbourne College.

Daniel D. Walker, Jr., Chief Chemist, United States Lime Products Div., The Flintkote Co., Henderson, Nev., a 1949 graduate of Brigham Young University.

Wayne L. Wilcox, Field Engineer, Arcos Corp., Philadelphia, Pa. Attended the University of Illinois.

Max L. Woehle, Assistant Pulp Mill Superintendent, Container Corp. of America, Brewton, Ala., a 1948 graduate of the University of Florida.

Jose I. Wolfenson, Plant Manager, Beacon S.A.I.C., Buenos Aires, Argentina, a 1946 graduate of the University of Buenos Aires.

Yasaburo Yamazaki, Research Member, Japan Atomic Energy Research Institute, Ibaraki-ken, Japan, a 1951 graduate of the University of Tokyo Graduate School.

Peter N. Yiannos, Student, The Institute of Paper Chemistry, Appleton, Wis., a 1956 graduate of Missouri School of Mines.

David E. York, Sales Representative, Crown Chemical Corp., Providence, R. I., a 1933 graduate of New Bedford Textile Institute.

TAPPI Notes

Maxwell D. Bardeen is now President of the Simpson Lee Paper Co., Vicksburg, Mich.

Lawrence P. Bauer, Jr., formerly Student at North Carolina State College, is now a research engineer for Ecusta Paper Div., Olin Mathieson Chemical Corp., Pisgah Forest, N. C.

Charles L. Brown is now Manager of the kraft pulp and paper mill of Crossett Paper Mills, Crossett, Ark.

John F. Butterworth of Mobil Oil Co. has been transferred from St. Louis, Mo., to Chicago, Ill., as District Manager for Process Products.

George S. Carroll has retired as General Superintendent of Newton Falls Paper Co., Newton Falls, N. Y.

James P. Casey, formerly of A. E. Staley Mfg. Co., is now Director of Starch Sales for Union Starch & Refining Co., Columbus, Ind.

Jim Challa, formerly Technical Superintendent of American Boxboard Co., is now with Fibreboard Products, Inc., Antioch, Calif.

James d'A. Clark is now Professor of Pulp and Paper Science at Oregon State College, Corvallis, Ore.

Theron T. Collins, formerly of Hudson Pulp & Paper Co., is now a Project Supervisor for American Boxboard Division, Filer City, Mich.

Ray H. Cross, formerly with Pandia Division, Black-Clawson Co., is now a Project Engineer with St. Regis Paper Co., Pensacola, Fla.

Robert Davie, formerly of W. R. Grace & Co., is now a Project Engineer for Beloit Iron Works, Beloit, Wis.

John J. Delisle, formerly Student at the University of Maine, is now a Production Trainee for the Oxford Paper Co., Rumford, Me.

Richard W. Detrick, formerly Student at The Institute of Paper Chemistry, is now a Project Engineer for Thilmany Pulp & Paper Co., Kaukauna, Wis.

Ronald A. Dykes, Plant Engineer of International Paper Co., Niagara Falls, N. Y., is now an officer Candidate in the U. S. Navy.

Arnold C. Eames, formerly Student at The Institute of Paper Chemistry, is now a Research Chemist for S. D. Warren Co., Cumberland Mills, Me.

Thomas C. Elias, formerly Student at Western Michigan University, is now a Student at the Institute of Paper Chemistry.

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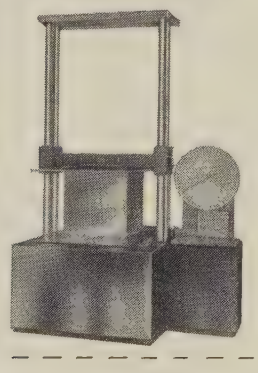

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Alfred P. Engelmann, formerly of du Pont, is now Technical Director of the Cryovac Div. of W. R. Grace & Co., Simpsonville, S. C.

Stephen A. Feeley is now President of Keystone Roofing Mfg. Co., York, Pa.

James E. Fenn, formerly Industrial Consultant, is now a Chemist for Morningstar-Paisley, Inc., Hawthorne, N. J.

Franco Ferretti, formerly of Cartiera Burgo, is now Engineer for Cartiera di Subrago, Rome, Italy.

Robert A. Flick is now Technical Director of Brunswick Pulp & Paper Co., Brunswick, Ga.

Alroy E. Frankfurter, formerly of Sandwell & Co., is now Principal of Frankfurter, Harstad & Associates, Seattle, Wash.

Fred H. Freuler is now Research Director of West Virginia Pulp & Paper Co., Covington, Va.

Cary S. Giles, formerly of Dewey & Almy Chemical Co., is now a Technical Salesman for Plastic Coating Corp., Holyoke, Mass.

Brage Golding, formerly of Lilly Varnish Co., is now Head of School of Chemical Engineering, Purdue Univeristy, Lafayette, Ind.

Karl M. Guest, formerly of Gulf States Paper Co., is now Assistant Manager of Pulp Manufacturing for the Brown Co., Berlin, N. H.

Fred H. Haile, formerly of Racquette River Paper Co., is now in the Technical Service Department of St. Regis Paper Co., Carthage, N. Y.

Lawrence B. Hawes, Jr., formerly of Scott Paper Co., is now Plant Engineer for Marinette Paper Co., Marinette, Wis.

Lloyd W. Heard is now Manager of Digester Sales for The Bauer Bros. Co., Springfield, Ohio.

Edward J. Heiser is now Manager of the Paper Section, Dow Chemical Co., Midland, Mich.

George R. Hunt, Jr., formerly of Nalco Chemical Co., is now a Senior Chemist for Minnesota Mining & Mgf. Co., St. Paul, Minn.

Richard C. Hutcheson of Union Bag-Camp Paper Corp. has been transferred from Savannah, Ga., to Spartanburg, S. C., as engineer.

John C. Hyatt, formerly of the Hammersley Co., is now a Dye Saleman for the American Cyanamid Co., New York, N. Y.

Nicholas A. Jappe, formerly Research Associate at The Institute of Paper Chemistry, is now in the Technical Department of W. R. Grace & Co., Paramonga, Peru.

Paul E. Jarvis, formerly of Finch, Pruyn & Co., is now a Project Engineer for the Great Northern Paper Co., Milinocket, Me.

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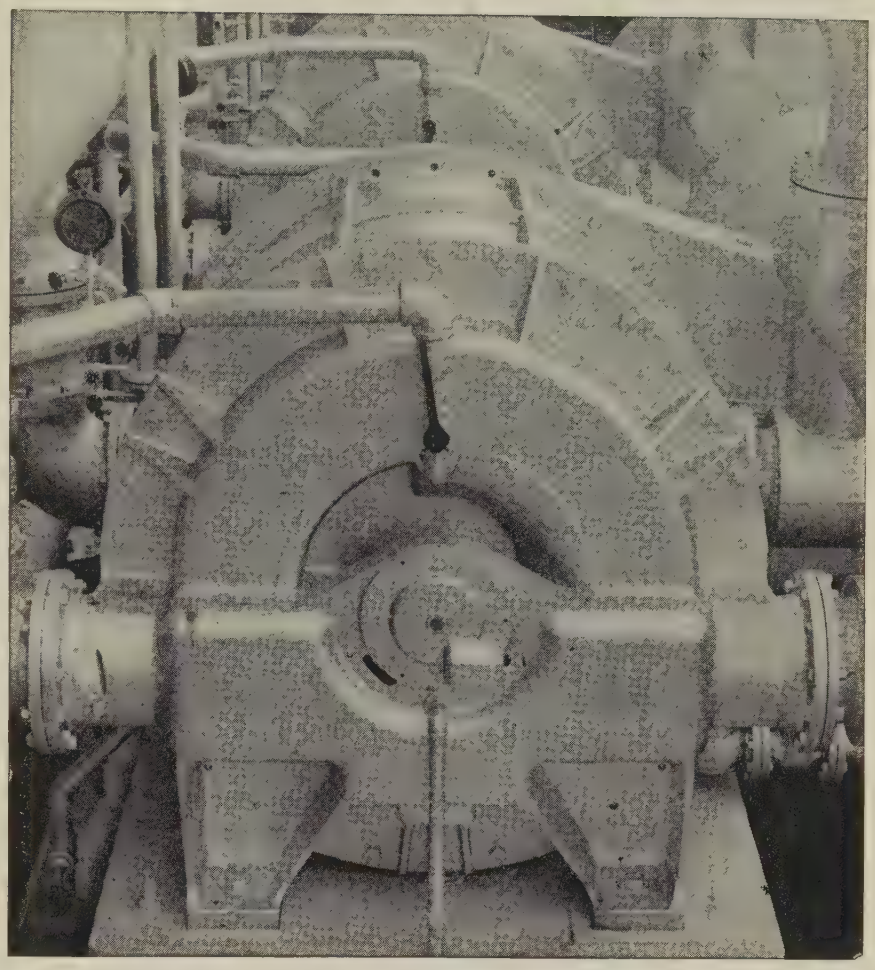

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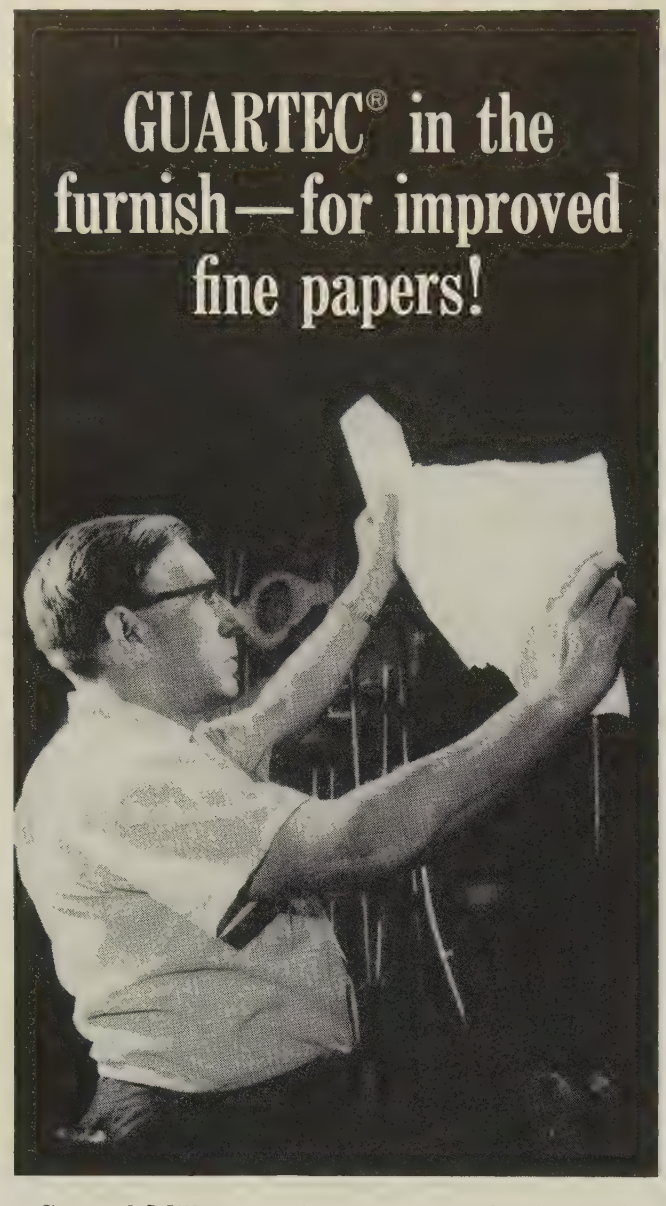

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General Mills

Leslie Justice, formerly of Sutherland Paper Co., is now Paper Mill Superintendent for Federal Paper Board Co., Inc., New Haven, Conn.

De Loss Kahl, formerly of Monadnock Paper Mills, Inc., is now Electrical Insulating Paper Sales Manager for Peter J. Schweitzer Division, Kimperly-Clark Corp., Lee, Mass.

Ferdinand Katzmayr, formerly of St. Lawrence Corp. Ltd., is now Technical Superintendent for the Container Corp. of America, Circleville, Ohio.

Lloyd L. Klinger, formerly of Central States Engineering, Inc., is now Technical Director and Assistant to the President, Whippany Paper Board Co., Whippany, N. J.

John W. Komanecky, Jr., formerly of Monsanto Chemical Co., is now with General Mills, Inc., Minneapolis, Minn.

Max A. Krimmel, formerly of Hammermill Paper Co., is now a Research Associate for the Herty Foundation, Savannah, Ga.

Alfred B. Layton is now Chairman of the Finance Committee of Crown Zellerbach Corp., San Francisco, Calif.

Ian C. Mac Gugan, formerly of Becco Chemical Division, is now Head of the Sales and Paper Section of Wyandotte Chemicals Corp., Wyandotte, Mich.

Bruce W. Martin, formerly of Diamond Gardner Corp., is now Vice-President in Charge of Manufacturing for Hudson Pulp & Paper Co., New York, N. Y.

James W. Maxwell, formerly of Potlatch Forests, Inc., is now with Gulf States Paper Corp., Demopolis, Ala.

Malcolm N. May is now Manager of Manufacturing for Gulf States Paper Co., Tuscaloosa, Ala.

James M. McClung is now Plant Engineer for the Oxford Paper Co., Lawrence, Mass.

Thomas N. McLenaghen is now Assistant Mill Manager of the Manitoba Paper Co. Ltd., Pine Falls, Manitoba.

Howard W. Meakin is now Head of the Pulp and Paper Department of J. E. Sirrine Co., Greenville, S. C.

J. Judson Mealy, formerly of Royal Lace Paper Works, Inc., is now Regional Production Manager of Hinde & Dauch Division, Sandusky, Ohio.

Robert S. Morgan, formerly Student at The Institute of Paper Chemistry, is now Assistant Technical Director of the Mohawk Paper Mills, Inc., Cohoes, N. Y.

Richard J. Moser is now Assistant Superintendent of the Papermaking Division of the K.V.P. Co., Kalamazoo, Mich.

William H. E. Neuss, formerly of Stein, Hall & Co., is now Manager of Research for Armour Alliance Industries, Alliance, Ohio.

William M. Newton is now Associate Director of Corporate Warehousing for the Mead Corp., Dayton, Ohio.

Sidney Nuss, formerly of A.P.W. Products Co., Inc., is now Assistant Mill Manager of Steiner Tissue Mills, Inc., Albany, N. Y.

Edward T. Parker, formerly of Ciba Co., is now in the Application Research Department of Wyandotte Chemicals Corp., Wyandotte, Mich.

David E. Peakes, formerly Student at the University of Maine, is now a Chemical Engineer for the Northwest Paper Co., Cloquet, Minn.

Donald E. Pohlman is now Chief Project Engineer for the Scott Paper Co., Chester, Pa.

Samuel J. Quattrocchi is now Vice-President and General Manager of the Alliance Paper Mills Ltd., Merriton, Ont.

Klaus W. Rosenfeld, formerly of West Virginia Pulp & Paper Co., is now manager of Pulp and Papermaking Research for Escher Wyss, Ravensburg, Germany.

Roger E. St. Pierre, formerly of the Brown Co., is now Quality Control and Research Manager for the Pittsburg Co., Wellsburg, W. Va.

George W. Sargent, Jr., formerly of Central Fibre Products Co., is now Engineer with Mercury Engineering Co., Milwaukee, Wis.

Joseph L. Schaan, formerly with Nordling, Mace & Cy, is now Manager of Beloit Paper-machine, Paris, France.

G. Wilbur Seymour, formerly Student at Lowell Technological Institute, is now Chief of the Research & Development Division of the Small Business Administration, Washington, D. C.

John L. Sigler, formerly of John W. Bolton & Sons, Inc., is now Director of Sales and Service for the Morden Machines Co., Portland, Ore.

George E. Soyka, formerly of John W. Bolton & Sons, is now a Consultant with George E. Soyka & Associates, Andover, Mass.

Charles C. Spencer, formerly of Williamson Adhesives Inc., is now Sales Representative for Mosinee Paper Mills Co., Pittsburgh, Pa.

Sinclair P. Strayer of St. Regis Paper Co. has been transferred from Tacoma, Wash., to Pensacola, Fla. as Assistant to the Pulp Mill Superintendent.

Samuel R. Sutphin is now Chairman of the Board of the Beveridge Paper Co., Indianapolis, Ind.

Frank J. Tappen, formerly of the Mead Corp., is now Sales Manager of Clemelex, Inc., Fort Edwards, N. Y.

Jack E. Weaver, formerly of Wolverine Fabric & Mfg. Co., is now in Sales-Service for Corn Products Sales Co., Cincinnati, Ohio.

Jay R. Willner, formerly of Roger Williams Technical Service, is now a Market Analyst for the Oronite Chemical Co., San Francisco, Calif.

John Willy, formerly of Glas-Kraft, Inc., is now a Consulting Chemical Engineer in Attleboro, Mass.

William A. Wheeler, formerly of Adams Paper Converting Co., is now Chief Engineer for Mead New Products Division, Cincinnati, Ohio.

Clyde D. Woodburn, Jr., of Corn Products Sales Co., has been transferred from Chicago, Ill., to New York, N. Y., as Assistant Manager of Sales Service.

Fred E. Woods is now Assistant Mill Manager of the bleached food board mill of Crossett Paper Mills, Crossett, Ark.

Robert A. Worden of Minnesota Mining & Mfg. Co. has been transferred from St. Paul, Minn., to the Hartford City Paper Division, Hartford City, Ind., as Laboratory Manager.

* * *

Arthur W. Plummer has succeeded *Raymond S. Hatch* (retired) as the official corporate representative of the Hudson Pulp & Paper Co., So. Windham, Me., in the Technical Association

Phillip A. Phillips has succeeded *E. R. Darling* as the official representative in TAPPI of the Louhoff Grain Co., Danville, Ill.

B. K. Tremaine has succeeded *S. A. Dunn* as the official representative in TAPPI of Rhodia, Inc., New York, N. Y.

Lawrence W. Egan has succeeded *Frank W. Egan* (deceased) as the official representative of Frank W. Egan & Co., Somerville, N. J., in the Technical Association.

F. Richard Convey, sales manager, has succeeded *Haigh Reiniger* as the official representative in TAPPI of John W. Bolton & Sons, Inc., Lawrence, Mass.

Industry Notes

PRODUCTION

Paper and board production for June, 2,910,979 tons, showed a 16% increase over that for June, 1959. Paper production alone amounted to 1,244,536 while that of paperboard was 1,150,798 tons. These figures are respectively 14 and 16% higher than those for June a year ago.

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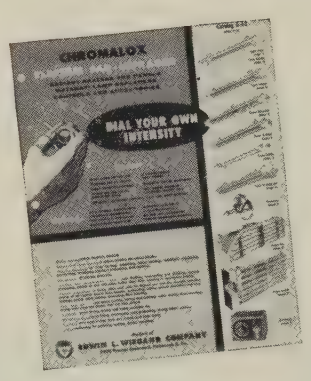

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Production of paper and paperboard during the first six months of 1959 totaled 17 million tons; the highest level of any first half in the industry's history. This is 13.6% above the first half of 1958 and 5% higher than the total in the corresponding period in 1956, the previous record-production year.

This increase was achieved by an 11.1% increase in paper production, a 15.4% increase in paperboard production, and a 17.2% increase in production of construction paper and board. Comparable first quarter totals showed paper up 8%, paperboard up 11% and construction paper and board up 17% from 1958 to 1959.

The 15.4% increase in paperboard production during the first half of 1959 reflected gains in practically all important segments of the paperboard total. Container board was up 17.6%, bending board up 12.5%, and nonbending board up 16.9%. Wet machine board production in the firsh half of 1959 was 4.7% ahead of last year. Building paper production, which was 14.6% ahead of last year at the end of the first 1959 quarter, was 6.3% ahead of 1959 for the half, while building board production, which was up 16.2% at the end of the first quarter, was 26.0% ahead of 1959 at the half, reflecting mainly a 44.8% increase in hardboard production.

Newspring production, which was 4.6% ahead of 1958 at the end of the first quarter of this year, was 8.5% above 1958 production at the end of the half. Production of machine-coated paper during the first six months of this year was about 1% above last year's comparable figure; production of paper coated on two sides was virtually unchanged in the 1959 first half from the year-earlier period, making this the only major grade of paper or board that did not show a gain for this period. Production of uncoated book, grades, on the other hand, was up strongly from the year-ago totals.

All grades of fine paper showed substantial production increased in the first half of 1959 over their comparable 1958 totals. The coarse paper segment, which was 8.3% above 1958 for the first quarter of this year, was up 13.6% for the half. Special industrial plus absorbent paper was up 28.8% over the year-earlier half, and sanitary tissue stock was up 8.2% in this period.

Wood Pulp

Production of wood pulp for the first six months of 1959 was 12,050,000 tons, an increase of 1,614,000 tons above the comparable 1958 total.

Wood pulp consumption in the manufacture of paper and board for the first six months of 1959 was 12,467,000 tons, an increase of 1,706,000 tons above consumption for the first six months of 1958.

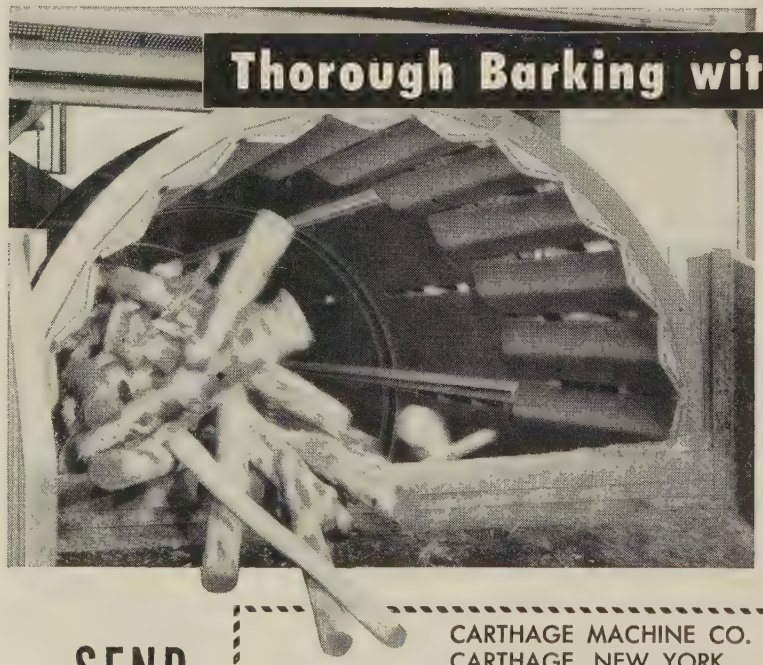
Imports of wood pulp for January to June, 1959, were 1,211,250 tons, an increase of 21% above for the first six months of last year. Imports from Canada for the first six months of 1959 were 997,243 tons, an increase of 17% over the comparable period of 1958. Overseas imports for the first six months of 1959 were 210,484 tons as compared to 123,073 tons in the first six months of 1958.

Exports of wood pulp for the first six months of this year were 289,521 tons, as against 271,525 tons exported during the same period last year.

Inventories of wood pulp at paper and board mills at the end of June were 545,000 tons, a decrease of 10,000 tons below inventories at the end of May and 8000 tons below inventories at the end of June, 1958.

Wastepaper and Other Fibrous Materials

June wastepaper receipts were 797,000 tons; for the first six months of this year they totaled 4,673,000 tons, an increase of 535,000 tons above receipts for the first six months of last year. Wastepaper consumption for June was 791,000 tons; the



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January to June total was 4,615,000 tons, an increase of 399,000 tons above consumption for the first six months in 1958. Inventories at the end of June were 495,000 tons, an increase of 6,000 tons above May, and 18,000 tons above inventories at the end of June, 1958.

Consumption of total fibrous materials for June was 883,000 tons; the January to June total was 5,151,000 tons, an increase of 1,116,000 tons above consumption for the first six months of 1958. Inventories of total fibrous materials at the end of June were 874,000 tons, 24,000 tons below May, and 4000 tons above inventories at the end of June, 1958.

Pulpwood

Total receipts of pulpwood for the first six months of 1959 were 18,047,000 cords, an increase of 1,679,000 cords over receipts for the comparable period of 1958. Domestic receipts were 1,751,000 cords above the year-earlier total, while imports declined 72,000 cords. All of the regions showed increases ranging from 5% in the West, to 14% in the South Atlantic.

Pulpwood consumption in the first six months of 1959 was 19,259,000 cords, an increase of 2,055,000 cords over the same period of 1958. The Northeast region showed a 1% decline in consumption while all other regions showed increases, ranging from 7% in the West to 17% in the South Atlantic.

Inventories of pulpwood at the end of June were 4,651,000 cords, a decrease of 184,000 cords below May,1959, and a 1,121,000 decline from June last year. All of the regions showed decreases, ranging from 9% in the South Central to 31% in the West.

Tasman Pulp and Paper

At the invitation of the board of Tasman Pulp and Paper Co. Ltd., of Auckland, New Zealand, and of Albert E. Reed & Co., Ltd. of London, England, negotiations have been taking place for The Bowater Paper Corp. Ltd. of London, England, to participate in the future management and development of Tasman Pulp and Paper Co.

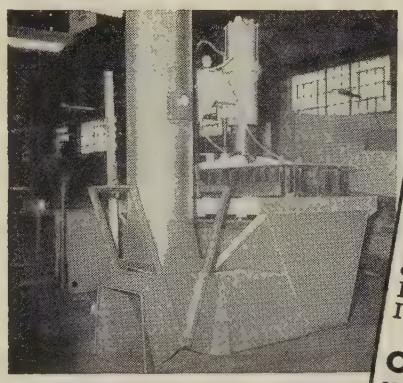
These arrangements provide, *inter alia*, for The Bowater Paper Corp. to subscribe additional share capital in Tasman Pulp and Paper Co., to be associated with Albert E. Reed & Co. in the future management, and to be responsible for the sales of the Tasman Co.'s products. Agreement has now been reached between the parties concerned and this has been approved by the New Zealand government subject to the approval of the shareholders in general meeting. The necessary formalities to give effect to the proposals have been put in hand.

In regard to future developments it is proposed that a second paper machine and ancillary plant will be installed as soon as possible to increase the annual capacity to 180,000 tons of newsprint.

Maine

Writing in the New York *World-Telegram and Sun* (Sept. 1) on his visit to Maine where he was the guest of several pulp producing companies, Mr. Ray Ovington, whose trip was sponsored by the American Forest Products Industry, summed up his visit by remarking that, "All in all, we can thank the large holders of the wilderness lands for maintaining for us an almost forever wild but always available, always usable forest." This observation was prompted by the work he saw being done by the various conservation departments of the State. Mr. Ovington pointed out that single ownerships of these vast tracts of land assured both the proper management of forests and the interest of the public. It is only because these lumber and pulp companies allow and encourage recreational facilities on their land that 90% of the upper part of Maine woodlands is accessible to the public. Recreational projects undertaken by the lumber companies include cleaning camping and boat launching sites along the lakes, the building

Automatic disposal of large broke sheets accomplished with use of crusher-shredder. Shredded pieces flow easily thru system, and are ready for proper baling or reprocessing.



Automatic trim removal from box stripper also provides a floor level pick up to keep the entire area clear.

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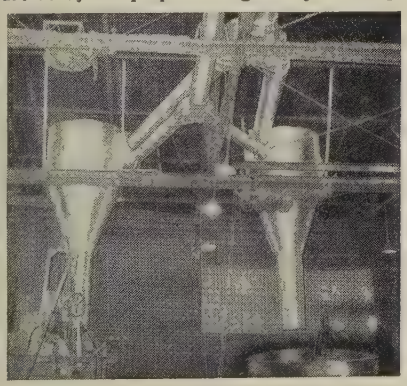
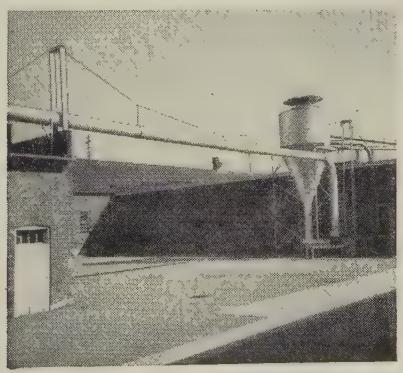
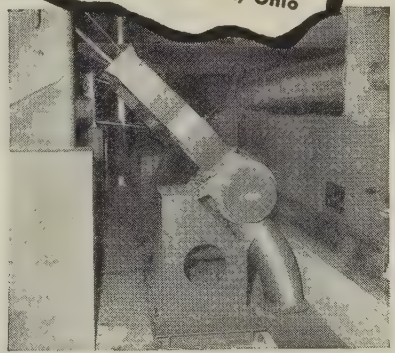


Reprocessing of boxboard trim. Two collectors, and special switching valves permit discharge of trim into *either* of two beaters.



Catenary suspension used to keep yard clear. Pipe runs from transfer collector to separate reprocessing location. Twenty feet of head room allowed for trucks and equipment.



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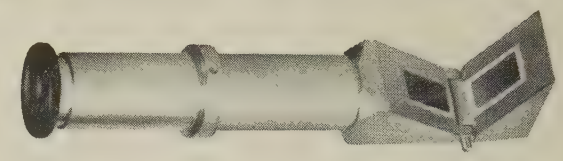

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of marinas, leasing plots for the erection of cabins, and the construction of ski lifts. Salmon fishways and holding weirs are some of the other projects that the various companies are working on together with the state.

According to Mr. Ovington, none of the pulp companies post their land, a growing problem among the small landowners, unless it be for temporary specific fire hazard or working situations where traffic would be against the good of the public.

Canada

A group-exchange visit has been arranged between the pulp and paper industries of Canada and the USSR, sponsored by *Pulp and Paper Magazine of Canada* with the official backing and cooperation of the CPPA.

A representative Canadian Group will visit the Soviet Union during the last three weeks of October. The itinerary will include a member of pulp and paper mills, and it is anticipated that several of the cellulose research institutes and the planning center of the Soviet pulp and paper industry will also be visited.

A return visit from a like number of executives of the Soviet pulp and paper industry will be made to the Canadian industry sometime during 1960.

As presently planned, the group from the Canadian industry will include:

Peter Harakas, chief engineer, The Ontario Paper Co. Ltd.
G. D. Hughson, director, Gatineau Div., Industrial Cellulose Research Ltd.
Douglas Jones, executive secretary, Technical Section, CPPA.
John L. Keays, supt. of research & development, Powell River Co. Ltd.
J. McK. Limerick, research director, Bathurst Power & Paper Co. Ltd. and 1959 chairman, Technical Section, CPPA
E. W. McBride, vice-president, Abitibi Power & Paper Co. Ltd.
F. A. Price, technical editor, *Pulp & Paper Magazine of Canada*
H. S. Spencer, mill manager, Howard Smith Paper Mills Ltd.
S. E. Williams, vice-president, St. Lawrence Corp. Ltd.

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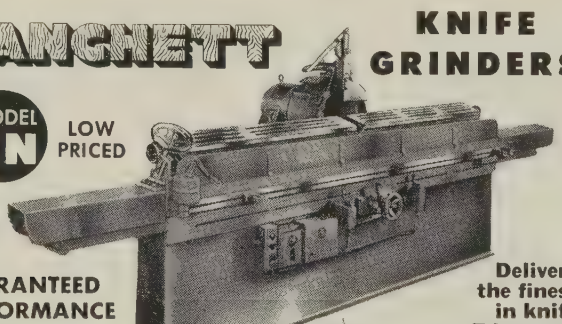

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First Paper Folding Show

Thousands of people have been taken into the fold. The paper fold that is. This year the nation's first full-scale exhibit of the ancient art of paper folding has recognized the artistic possibilities of paper.

Increased use of paper is visualized as more people become intrigued by a hobby that can well complete with painting and clay modeling. This is one of the conclusions inspired by the first national paper folding exhibition held this summer at the Cooper Union Museum in New York City, N. Y., as part of its 100th anniversary celebration.

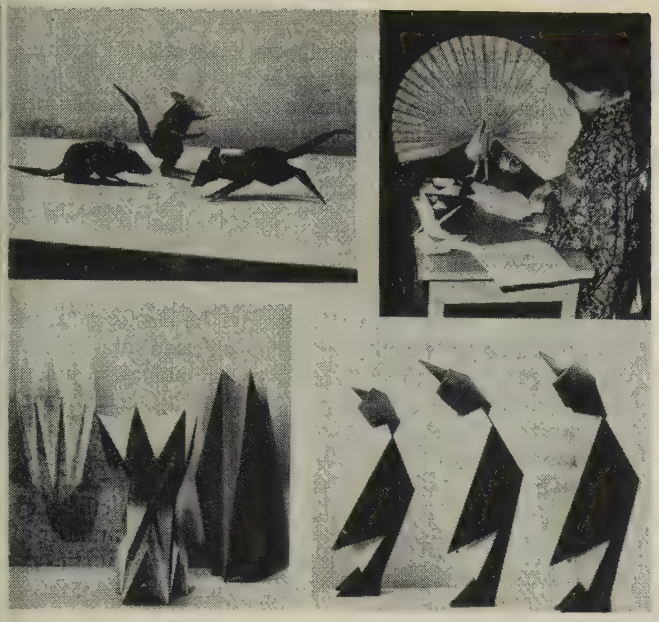
In the Western World until recently, paper folding has for the most part been confined to the children's world of paper party hats and paper airplanes.

But in the Orient, where paper as we know it was first invented 10 centuries ago, paper fold has existed in a highly developed form for over a thousand years, or almost as long as paper itself.

In the Cooper Union exhibit, whimsical creatures of land, sea, and air; butterflies, bats, and beetles; chickens, penguins and kangaroos, perch side-by-side in showcases with fantastic folded flowers and myriads of strange and intricate geometrical folded forms.

The Japanese call paper folding "Origami," and as it has been pursued in Japan it approaches the sculptural art in its expression and technique.

"Many Japanese paper folds have complex symbolic meanings which are linked with the stylized traditions of the Japanese," says Prof. Calvin S. Hathaway, director of The Cooper Union's Museum for the Arts of Decoration, which gathered rare examples of paper folding from private collections in Japan, Spain, Argentina, and the United States. "Yet each skilled artist," he said, "can create a traditional



fold pattern with a fresh approach that makes it an individual work of art."

Among the popular subjects of the origami artist are such traditional Japanese figures as the crane and tortoise, both symbols of food, fortune, and long life; the carp, symbol of persistency and aspiration, and the frog, an emblem of love and fertility.

In addition, folded paper takes its place in the graceful complicated etiquette of Japanese life. Folded paper decorations are attached to gifts; but with the proper emblem on the proper gift for the proper occasion, of course. And, as early as the beginning of the eighteenth century, a "how-to-do-it" book was published in Japan complete with diagrams and instructions for making the traditional paper decorations.

Although the Western World is a johnny-come-lately to paper folding as an art, it has produced some famous folders. Leonardo da Vinci was one, and so was Lewis Carroll, the beloved author of Alice in Wonderland.

Leonardo, in his famous scientific essays, used folded forms for simple visual illustrations of his inventions and theories. Indeed, one of these is almost a dead-ringer for the folded paper airplane of today.

Modern geometry still turns to paper folding. No better technique has yet been devised to show the three dimensional construction of polygons and circles of Euclid. And architects and engineers utilize the method widely in experimenting with principles and architectural forms, as can be seen in flipping the pages in any architectural magazine.

Children of course adore the frivolity of paper folding for fun.

Lewis Carroll knew this and tells of entertaining the royal children of the Duchess of Albany in his country home, where he amused them by folding a fishing boat, and later initiating "the little Duke of Albany in the art of making paper pistols."

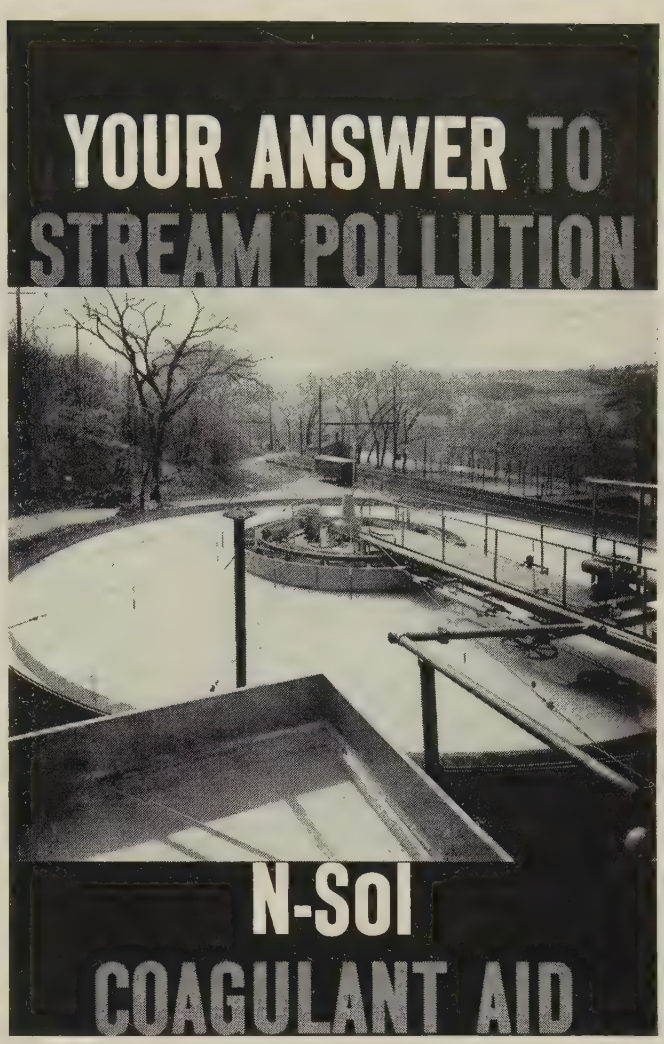
Then there was the little girl, mute from fear of people, who uttered her first words while carried away with delight over a folded paper bird with wings that flapped friskily when its tail was pulled.

To be sure, youngsters are not the only ardent converts to folding. The Cooper Union Museum's guest book this summer attests to that.

Businessmen are coming in droves to the bi-weekly demonstration lectures, and it is predicted that the fanciful fold rather than the dreary doodle will be soon the fashion at business conferences.

Occupational therapists come to pass folding techniques on to the handicapped and the shut-in.

Teachers in large numbers are seen at the Museum's "do-



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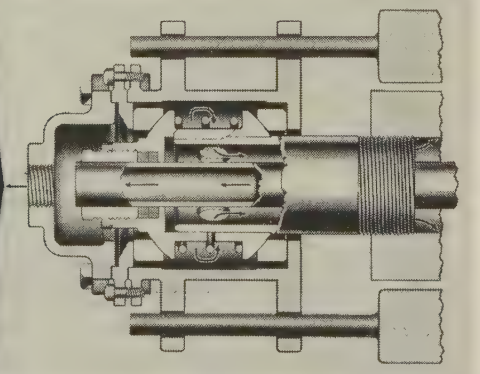

THE JOHNSON CORPORATION
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it-yourself" table, which is complete with piles of paper and diagrams, and they rub busy elbows with artists, lawyers, housewives, and elderly retired people.

The advice of Akura Yashizawa of Tokyo, the acknowledged master paper folder of the world is "never fold on a rainy day."

Still, perhaps folding may help to make a rainy day sunnier. You just need a lot of paper.

Color Reduction of Bleaching Waste

A new method for removing color from caustic extract bleaching waste is under investigation by the National Council for Stream Improvement, Inc., at Louisiana State University. This process employs adsorption of the color bodies on a mass of hydrated lime, and is integrated with the mill causticizing system in such a manner that they are redissolved in the white liquor, and ultimately burned in the black liquor furnace. Results to date indicate that the presence of the color bodies have little effect on either causticizing efficiency or settling. Laboratory tests are being made at a number of bleached kraft mills employing their individual caustic extract, reburned lime, and green liquor.

Plant Maintenance Show

After an interval of four years, the Plant Maintenance & Engineering Show will return to the East in 1960, it was announced by Clapp & Poliak, Inc., New York, producers of the exposition and the extensive conference which is held at the same time.

The four-day show will be held at Convention Hall, Philadelphia, January 25–28, and the concurrent conference during the first three days, January 25–27.

The show, one of the largest and most important in the country, has been held in the East only twice before, in 1952 and 1956.

The exhibits have grown substantially in both number and size in the intervening years. All available space in Convention Hall will be needed to accommodate the displays. One of the most important new aspects of the exhibits—never shown in the East before—will be the various products and equipment used to eliminate factory pollution of air and water. The pollution problem is an important source of difficulty both to management and the communities in which plants are located.

Virtually all exhibits will emphasize cost reduction through preventive maintenance, a system which anticipates breakdowns and avoids them.

Advance registration cards, conference and hotel information, may be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y.

Fiber Cans

Fiber cans and tubes, widely used to package America's products—everything from fishing poles to frozen strawberries—are enjoying the greatest sales year in the history of the industry.

Paul S. Hanway, managing director of the National Fiber Can and Tube Association whose members produce the major output of fiber cans and tubes in the nation, said that the industry's total volume up to August 1 this year was 19% higher than during the comparable seven-month period a year ago.

That segment of the industry which manufactures only for sale is operating on an annual basis of $125 million, and an additional $25 million in volume is absorbed by other industries producing fiber cans and tubes for their own uses.

For the remainder of the year, Mr. Hanway forecasts a continuing business gain as more and more packagers turn to the use of fiber cans and tubes for their "bonus" sales appeal, product protection, convenience, and economy.

He explained that until a few decades ago the consumers' most common association with fiber cans was for their use for

cleanser, oat cereal, and table salt and with fiber tubes for wax paper and aluminum foil. But today these represent only a fraction of more than 100,000 different kinds of fiber cans and tubes that are available.

Hudson Pulp and Paper

Hudson Pulp & Paper Corp., New York, N. Y., has appointed Bruce W. Martin, vice-president-manufacturing.

Bruce W. Martin, Hudson Pulp & Paper Corp.

Mr. Martin joins Hudson from Diamond Gardner Corp., where he held positions as administrative vice-president of the Gardner Division, Middletown, Ohio, and vice-president of manufacturing of the Gardner Board and Carton Co. He also has been associated with Union Bag-Camp Paper Corp., Savannah, Ga., as general mill superintendent, Filer Division of American Boxboard Co. and Gaylord Container Corp.

In his new post, Mr. Martin will be responsible for the organization and operation of Hudson's mills and converting facilities located in Augusta, Me., Palatka, Fla., Bellows Falls, Vt., Pine Bluff Ark., Wellsburg W. Va., and Carteret N. J.

A native of Big Springs, Tex., Mr. Martin received his B.S. and M.S. degrees in chemical engineering from Louisiana State University. He is a member of TAPPI.

Imperial Color Chemical & Paper

The Imperial Color Chemical & Paper Corp. announces the election of Alfred E. Van Wirt as executive vice-president. He is currently vice-president and technical director.

A native of Glens Falls, Mr. Van Wirt attended Cornell University, graduating in 1923. Employed by the Allied Chemical Corp. in Philadelphia from 1923 to 1925, in the latter year, he returned to Glens Falls as a production staff assistant with Imperial. In 1930, he was assigned to administrative responsibilities in the Wallpaper Division. During his years in the Wallpaper Division, Mr. Van Wirt developed a number of "firsts" in the wallpaper industry. Among these achievements was the introduction of light-fast and washable wallpapers.

In 1935, Mr. Van Wirt was named technical director in charge of all research laboratories, as well as engineering and technical operations. He was elected to the Board of Directors in 1946 and became vice-president in 1953.

Mr. Van Wirt has long taken an active interest in technical developments in the pulp and paper industries and in the industrial areas served by chemical colors. He is a member of the scientific committee of the National Paint, Varnish, and Lacquer Association.

Stone Container

Norman H. Stone, president and chairman of the board of Stone Container Corp., Chicago, announced the purchase for an undisclosed cash figure of the Delmar Paper Box Co., 4625 Red Bank Road, Cincinnati, Ohio, 34-year-old manufacturer of setup and folding boxes.

Stone Container Corp. owns and operates 11 manufacturing facilities, consisting of paper mills, corrugating plants and setup and folding box plants in Illinois, Indiana, Ohio, Michigan, Pennsylvania, and Alabama; annual sales for the corporation are approximately $40 million. "Acquisition of the Delmar Paper Box Co.'s plant and organization," Mr. Stone said, "will provide our company with a long-desired nucleus for the expansion of our folding box sales in southern Ohio and bordering states."

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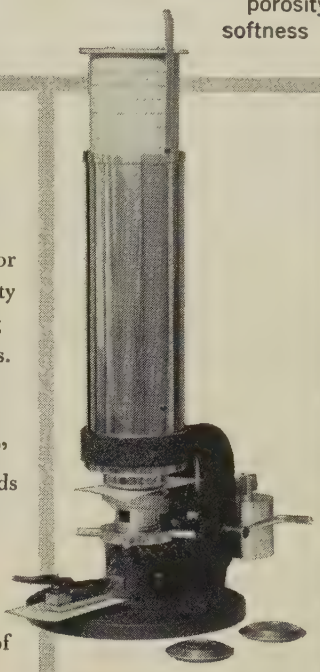
Write for Bulletin 1400, describing complete line of Gurley paper testers.



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Ira Pirman, retiring president of Delmar, will continue to serve the acquired organization in a consulting capacity. The business of the Delmar Paper Box Co. will continue under the management of Ralph Pirman, as a division of Stone Container Corp.

"Additional equipment for the manufacture of folding boxes will be installed in order to meet customers' requirements." Mr. Stone said.

Legal matters for the acquisition were handled by Lewis Shaffer, general counsel for Stone Container Corp., Chicago, Ill., and Gordon L. Wolf of Cohen and Wolf, Cincinnati, attorney representing the Delmar Paper Box Co.

West Virginia

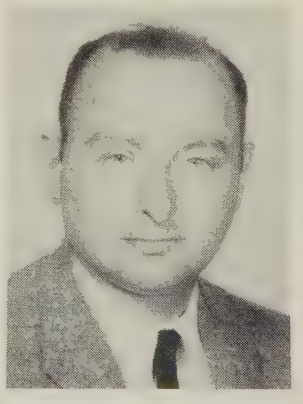
Arthur M. Stern is being transferred from the Covington Research Laboratory to Washington, D. C., where he will open an office. His move is in connection with responsibilities recently added to his position as head of microbiological research for West Virginia Pulp and Paper Co., Covington, Va.

In making the announcement, F. H. Freuler, research director, noted that Dr. Stern in the past two years has set up broad research programs covering slime control, river pollution abatement, and other biological problems. In addition to this, Dr. Stern has now taken on duties as coordinator for the company's research efforts in the food additive field, West Virginia Pulp and Paper manufactures a number of paper and paperboard grades that go into food packaging.

Freuler said, "Additives, such as coloring and chemicals used in the manufacture of food board, is a highly technical field. It is becoming so complicated that we have found it necessary to have a scientist of Dr. Stern's caliber set up an office in Washington where he can readily be in touch with the federal Food and Drug Administration. By being in touch with FDA officials, Dr. Stern will be able to keep our operating divisions informed promptly of developments, and this will help us keep ahead of our competition in the field of food board and related products."

Dr. Stern will continue to consult with various Westvaco divisions on slime control and pollution abatement. His central location in Washington will make it possible for him to reach all company locations more easily. Dr. Stern's laboratory research work will continue under his direction at the Covington research center.

Dr. Stern joined West Virginia Pulp and Paper Company in July, 1957. His profession is a highly scientific field that deals with the study and useful control of bacteria and other microorganisms. These tiny, microscopic "bugs" can be useful or destructive and a microbiologist can by chemical means get rid of "destructive bugs" such as the type that create slime (a jellylike substance) in pulp tanks and pipes. Slime interferes with efficient quality production—a high-cost problem in the paper industry. On the other hand, a microbiologist cultivates "good bugs" such as those used to restore oxygen and clean up paper mill wastes before being discharged to rivers.



Arthur M. Stern, West Virginia Pulp & Paper Co.

Dr. Stern received his bachelor's degree in biology and his M.S. and Ph.D. in bacteriology at the University of Illinois. Upon completion of his studies, he became a professor at Rutgers University where he taught bacteriology for six years. Later he joined West Virginia Pulp and Paper Co. at the Covington Research Laboratory.

Weyerhaeuser

The word "timber" will be dropped from the name of Weyerhaeuser Timber Co. on Sept. 1, it was announced today by Pres. F. K. Weyerhaeuser.

At the same time, Weyerhaeuser Co. will adopt a new symbol for the products it manufactures at plants in 26 states, an abstract tree within a triangle.

The name change was approved by shareholders at their annual meeting last May. It will apply only to the parent company and Weyerhaeuser Sales Co. Other subsidiary companies will retain their names but will adopt all other phases of the new identification system.

On October 1, Weyerhaeuser Sales Co. operations will become a part of the lumber and plywood division. The move is designed to "effect maximum coordination among manufacturing, distribution, sales and customer service activities," it was stated.

The Kieckhefer-Eddy division title, created in 1957 by the merger of Kieckhefer Container Co., and The Eddy Paper Corp. with Weyerhaeuser, will be discontinued. Its operations will be grouped under divisional titles descriptive of function or product.

Existing company brand names, such as 4-Square lumber, Quad-lok containers and Weytex hardboard, will be retained but will be supplemented with the new symbol.

At eight integrated mill sites in western Washington and Oregon, Weyerhaeuser produces containerboard, kraft and sulphite pulp, Prestologs, plywood, hardboard, lumber, bark and wood fiber products, home and industrial insulation, particle board, Ply-Vaneer, chemicals and moldable wood fiber. Pulp and paperboard is manufactured at mills in Michigan, New Jersey, and North Carolina. Milk cartons are produced in 11 states. Shipping containers and folding cartons come from 24 plants in 18 states.

Oliver P. Morgan was promoted to technical director of the Springfield Pulp Div. Morgan has been with Weyerhaeuser for 22 years, and chief chemist at the Springfield operation since 1949.

Donald E. Allen is now chief chemist. He came to Springfield Pulp Div. in 1949.

Weaver R. Stiles was promoted from paper-machine tender to machine-room tour foreman. Stiles has also been with the Springfield Pulp Div. since 1949.

Crossett

Crossett Paper Mills, Crossett, Ark., has announced the promotion of nine men to complete the organization of its new Production Department.

According to J. C. Hair, Manager of the Crossett Co.'s Paper Division, the following appointments have been made:

W. B. Jenkins promoted to a new position, assistant mill manager of the kraft operation; he was paper mill superintendent in the kraft mill.

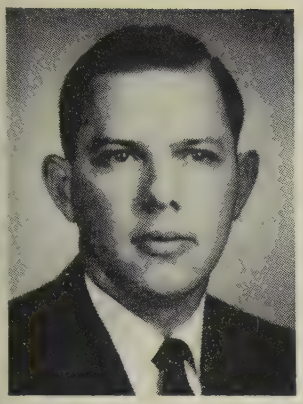
William B. Jenkins, Crossett Paper Mills, Crossett, Ark.

F. E. Woods steps up to the new position of assistant mill manager of the bleached food board mill, he was assistant paper mill superintendent of that installation.

A. G. McCaughan is now kraft paper mill superintendent after serving there as assistant superintendent.

L. C. Thomas has moved up to assistant superintendent of the bleached food board mill from his position as tour foreman.

Q. W. Vancleave has taken over the responsibilities of assistant paper mill superintendent in the kraft mill, he was in the technical service department.



Fred E. Woods, Crossett Paper Mills, Crossett, Ark.

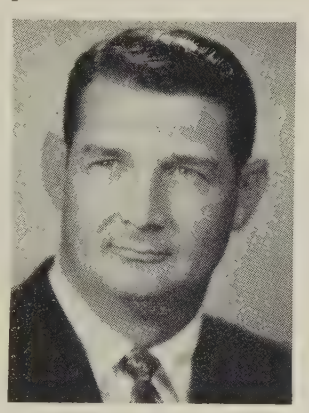
A. G. McGaughan, Crossett Paper Mills, Crossett, Ark.

W. W. Webster has become assistant pulp mill superintendent of the food board mill, he was a tour foreman.

E. F. Walling has been named a machine-room tour foreman in the food board mill, moving up from his post as a machine tender.

D. C. Rogers is now a permanent tour foreman in the food board pulp mill, he formerly held that position on a temporary basis.

L. B. Linder has become a pulp mill tour foreman in the board mill, he was working there as a pulp mill operator.



John T. Allen, Crossett Paper Mills, Atlanta, Ga.

Crossett Paper Mills has opened a new sales office in Atlanta, Ga. John T. Allen, formerly located in Crossett's Cincinnati paper sales office is in charge of the new outlet.

Location of the office is 3127 Maple Drive, NE, Suite 210.

"The opening of this new office in Atlanta, one of America's fastest growing markets, gives us an opportunity to provide better service to our customers in the Southeast," said J. C. Mulholland, Sales Manager.

Mr. Allen's move to Atlanta completes the reorganization of the paper sales organization started earlier this summer when two new area sales managers were named. They were J. W. Taylor, Eastern Sales Manager with offices in New York City, and Don Hodge, Western Sales Manager, with offices in Chicago.

Mr. Allen has been associated with Crossett Paper Mills in a sales capacity since 1952. All of this time has been spent in the Cincinnati office.

Finch, Pruyn

The complete modernization of the finishing and converting department of Finch, Pruyn and Co. Inc., Glens Falls paper manufacturer, is rapidly nearing completion, as the new addition to the stock storage area receives its finishing touches. The entire operation is rated as one of the most modern and streamlined in the industry.

Finishing, converting, and paper stocking operations are installed in a building recently erected specifically for the purpose, and the entire layout was designed for efficiently processing the output of three paper machines capable of turning out many different types of paper.

The expansion and additional equipment was made mandatory by the fast growing demand for Finch, Pruyn's paper grades utilizing its hardwood neutral sulphite pulps. Principal grades of paper produced include bleached, uncoated printing papers for letterpress and rotogravure, surface-sized uncoated stock for offset and duplicating processes, suface-sized bonds and writing papers for business forms, adding machine rolls and tablets.

The company's "Finch" grades are made principally of hardwood neutral sulphite pulps. "Cooper's Cave" and "Mohican" brands are a blend of neutral sulphite and groundwood pulps.

In the new finishing setup, one of the converting sections is horseshow in shape, with elvelators, roller conveyors, airflight off-table and other components properly placed for speeding the paper to the carton or skid packing operation, and keeping manual lifting to a minimum. A newly installed 10-roll Clark-Aiken cutter sheets 114-in. rolls at 550 f.p.m., and is supplemented with a 110-in. Hamblet cutter. Moisture-addition equipment keeps controlled relative humidity during winter months.

A Hayssen ream sealer and an ABC carton sealer set up in line to receive paper cut by a new Seybold 65 in. trimmer and Brackett trimmer provide fast efficient production of $8^1/_2$ by 11 and $8^1/_2$ by 14 sizes of Bond, Offset, Mimeo and Duplicator.

Visitors are welcome to inspect this modern plant.

K. C.

The election of William R. Kellett as president and G. Kenneth Crowell as executive vice-president of Kimberly-Clark Corp., Neenah, Wis., was announced on Aug. 26 at a meeting of the board of directors at which John R. Kimberly was re-elected chairman of the board and chief executive officer.

Kellett succeeds Kimberly as president of the firm; Crowell had been vice-president and secretary.

The board also advanced two vice-presidents and elected two new officers. Lewis E. Phenner and Andrew G. Sharp were elected senior vice-presidents. New officers are William J. French, vice-president of sales for consumer products, and William W. Cross, vice-president of sales for industrial products. Roger A. Baird, assistant secretary, was elected secretary.

The board also declared a regular quarterly dividend of 45 cents per share of common stock payable Oct. 1 to stockholders of record Sept. 11.

Kimberly-Stevens

Kimberly-Clark and J. P. Stevens and Co. Inc., have joined forces to form a new subsidiary, Kimberly-Stevens. K-S will produce and market nonwoven fabrics; these are used as inner linings in neckties and suits for surgical packs, inner soles of shoes, and many other items. Joseph J. Sutherland, the recently retired vice-chairman of Stevens, will be president of the the new company.

International Paper Co.

International Paper Co.'s Single Service Division, New York, N. Y., announced plans to build a plant to manufacture Pure-Pak paper milk containers at Framingham, Mass.

C. S. Edgar, division general manager, said a six-acre site has been acquired for the 50,000-sq. ft. structure from Cerel-Perini Associates, Inc., in the Framingham Industrial Center. Construction of the modern, single story building will begin this fall with completion scheduled for spring, 1960.

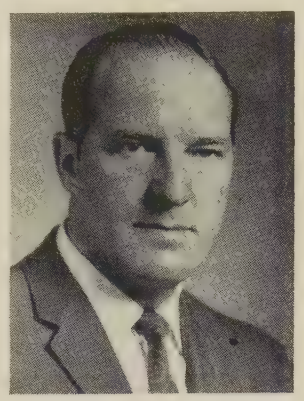
The new plant will be located on the Massachusetts Turnpike about seven miles northwest of Framingham. Mr. Edgar said that the facility is being built to provide better service to the New England dairy industry and will have a rated capacity of approximately 35 million paper milk containers monthly.

The Framingham plant will be the fourteenth to be operated

by the Single Service Division. Other plants are located at Kalamazoo, Mich.; Philadelphia, Pa.; Bastrop, La.; Kansas City, Kan.; Atlanta, Ga.; Youngstown, Ohio; Pelham, N.Y.; Waco, Tex.; Minneapolis, Minn.; Turlock, Calif.; Raleigh, N. C.; Miami Beach, Fla.; and Versailles, Ky.

St. Regis

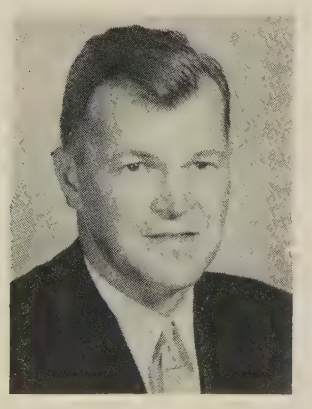
St Regis Paper Co. announces a reorganization of its technical activities: Dr. Kenneth A. Arnold becomes director of research and development and will be responsible for the company's research and development programs in the fields of pulping, papermaking, coating, polymers, packaging materials, engineering physics, by-products, and graphic science. Dr. Arnold received his B.S. in chemical engineering from Syracuse University, and his Ph.D. in chemistry from The Institute of Paper Chemistry in Appleton, Wis.



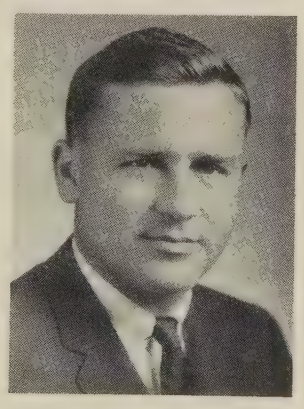
K. A. Arnold, St. Regis Paper Co.

Dr. Robert W. Reed has been appointed director of technical services and control. He is responsible for quality control and technical services to manufacturing and sales on printing papers, kraft papers, multiwall bags, and packaging materials. He received his B.S. in chemical engineering from the University of Rochester, and his M.S. and Ph.D. degrees from The Institute of Paper Chemistry.

Thomas A. Hewson has been appointed director of technical planning with responsibility for operations research; technical-economic evaluations of projects, products, and processes; liaison with intercompany groups concerned with market analysis, product development, and patents; and for budgeting technical operations. He received his B.S. in mechanical engineering from M.I.T.



R. W. Reed, St. Regis Paper Co.



T. A. Hewson, St. Regis Paper Co.

A new kraft paper and paperboard machine will shortly be constructed at the company's mill in Tacoma, Wash. The new machine, which will initially have a daily capacity of 350 tons of kraft paper and board, will increase the rated capacity of the Tacoma mill to 250,000 tons annually.

Georgia Kraft

John C. Baumgartner, formerly technical director of Georgia Kraft Co., Macon, Ga., has been appointed technical superintendent of Tennessee River Pulp & Paper Co., Counce, Tenn.

Brown

The Brown Co., Berlin, N.H., has announced the appointment of Karl M. Guest of Demopolis, Ala., as assistant manager of pulp manufacturing. At the same time, the promotions of Theodore I. Montelin to the position of steam engineer, and of Edward L. Lynsky to that of power engineer have been announced by George Craig, chief engineer.

Guest whose responsibilities will cover both kraft and sulphite mill operations, has been associated with pulp and paper manufacturing since he graduated from Clemson University in 1936. He has held various technical and supervisory manufacturing positions with Union Bag, National Container Corp., and Gulf States Paper Corp. During World War II, he served with the United States Army Chemical Warfare Division in the South Pacific. He is married and has one son.

Montelin, who has been maintenance engineer in the Brown Co. Power and Steam Dept. since 1953, will assume responsibility for all steam generation and departmental mechanical maintenance, reporting directly to Henry Stafford, chief power engineer. He has been with the company since 1951 and resides in Berlin with his family.

Lynsky, formerly assistant to Stafford, will supervise all electrical generation and power maintenance functions. He has been a member of the Engineering Department at Brown Co. since 1951, and is a graduate of Northeastern University. Lynsky will also report directly to Stafford.

A.E.H. Fair has resigned as president and director of the company and its subsidiaries and affiliates. The Board of Directors has accepted his resignation, effective September 16.

Rayonier

A new bleached sulphate mill at Woodfibre, B. C., Canada, is to be built by Rayonier Canada Ltd., it was announced recently at Vancouver, B. C., by W. E. Breitenbach, president.

The company, a subsidiary of the United States chemical cellulose producer Rayonier Inc., has also announced a change in its name from Alaska Pine & Cellulose Ltd. to Rayonier Canada Ltd.

Construction contracts are to be let immediately. When completed, the new mill will employ approximately 375 men and will produce some 250 tons of high quality bleached kraft pulps per day. Provision is also being made for future expansion, Mr. Breitenbach revealed.

The new mill is expected to be completed and on stream early in 1961. Its site is the location of the company's old mill, much of which will be demolished.

The old mill at Woodfibre produced bleached sulphite pulp for paper and chemical cellulose. Because of major advances in cellulose technology with the resulting extreme competition from new plants, it faced a continuing decline in demand for its products. It was shut down in June of 1958.

The new mill is another major undertaking in the company since Rayonier acquired controlling interest in 1954. This new expenditure is in addition to the more than $20 million Rayonier has invested in capital equipment in the subsidiary since January, 1955, including a large expansion and modernization program at the Port Alice, B. C., mill completed last year.

The Woodfibre development was seen to be a further step in the integrated utilization of the company's forest resources. Two species of wood, cedar and fir, previously unused in the company's chemical cellulose mills, will add to the wood supply. In addition, chips will be obtained from the company's two large sawmills at New Westminster and Marpole, B. C.

An earlier step in full wood utilization occurred in 1956 when a one million dollar plant was built at the Marpole sawmill to produce "Rayflo" from hemlock wastes. "Rayflo"

is a silvichemical developed by Rayonier Research for use in oil well drilling.

Dr. Louis H. Bock of Rayonier's Olympic Research Div. at Shelton, Wash., becomes assistant manager of that research center, it has been announced by Dr. R. L. Mitchell, general manager of research.

Dr. Bock, who has been with the chemical cellulose producer since 1950, is known for pioneering work on linear polyester fibers from lignin sources and for his publications on cellulose ethers and thermosetting resins. He holds numerous patents on cellulose derivatives, textile finishing agents, and resins.

His initial work at Rayonier was as a group leader at the Shelton research facility. He became research coordinator in 1957. Prior to his association with Rayonier, Dr. Bock had been with Rohm & Haas Co. at Philadelphia. A graduate of Kansas State College, Dr. Bock received both his M.S. and Ph.D. at the University of Illinois. He is a member of the A.C.S., Forest Products Research Society, TAPPI, Phi Lambda Upsilon, and Sigma Xi.

In Victoria, B. C., a special shareholders meeting held on September 1 changed the name of Alaska Pine & Cellulose Ltd., Rayonier Incorporated's Canadian subsidiary, to Rayonier Canada Limited to avoid being confused with its closest competition in world markets.

W. E. Breitenbach, the subsidiary president, reported that the change became urgent when it was learned that "the name of our latest cellulose and pulp competitor in Alaska was the same as ours when translated into the language of a customer country—Japan."

He observed that since statehood the name "Alaska" now occupies a revived and more specific geographical meaning in commerce. All Alaska Pine mills are in British Columbia, and the name Alaska Pine was adopted by the company 20 years ago to identify and market western hemlock lumber, then not so saleable as it is today.

The name Rayonier Canada Ltd. was chosen because of the substantial research, manufacturing and marketing ties with the major U. S. A. chemical cellulose producer, and to give clear indication of the Canadian origin of the products.

The new name became effective Oct. 1, 1959.

Canadian International

Top Canadian and United States engineering firms are pooling talents and resources to build the new fourdrinier machine for the La Tuque mill of Canadian International Paper Co.

W. T. Bennett, C.I.P. vice-president, engineering, stated that Dominion Engineering Co. Ltd., Lachine, Que., and Beloit Iron Works, Beloit, Wis., will install the unit for the production of kraft paper and board. Dominion and Beloit will each supply approximately 50% of the components. The unit, which will have a 176-in. wire, will be 400 ft. long, 20 ft. high, and weigh 2500 tons. Power requirements are 6000 hp.

"The machine has been designed for maximum flexibility in the production of bag and wrapping papers and also bleached foodboards," Mr. Bennett explained.

Annual production of the unit is estimated at 35,000 tons, but as a result of improved methods of processing and greater mill efficiency, it will be kept supplied with pulp without reducing the market pulp available from the La Tuque mill.

The $10 million expansion program at La Tuque includes installation of a laminating machine to produce heavier bleached boards for drinking cups and foodboard. The laminator, supplied by Black-Clawson (Canada) Ltd., Montreal, is a 3-ply unit with a trim width of 86 in. Eighty feet long, 12 ft. high, and weighing 100 tons, it will call for 300 hp.

Design work has been arranged with Durnford, Bolton, Chadwick & Ellwood, architects, and Foundation of Canada Engineering Corp. Ltd, engineers. Foundation Co. of Canada Ltd., Montreal, have been awarded the contract to build the machine—room extension 940 ft. by 68 ft. for the paper machine.

Provision for expansion was made in the original construction of the machine—room. The laminator will be located in a section of a new warehouse, 720 by 90 ft., which will supply additional storage facilities. This is also being built by foundation.

Between 500 and 600 men will be employed at the peak construction period and completion is scheduled for early 1961. When the new machines are in production, they will add a number of permanent jobs to the existing work force of 1200 at the mill in La Tuque, a town of more than 10,000 people.

The present daily rated capacity of the mill is 530 tons of bleached and unbleached sulphate pulps and 325 tons of kraft linerboard, kraft paper, and bleached kraft board. Some 250 gal. of turpentine are also produced daily.

Mead

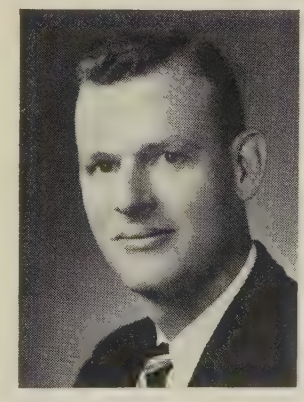
William M. Newton has been named associate director of corporate warehousing for The Mead Corp. Dayton, Ohio. In announcing the promotion, George H. Pringle, executive vice-president, said that Mr. Newton will have his office in Dayton and will report to Robert P. Arvold, recently appointed coordinator of central planning, white papers.

The new associate director of corporate warehousing will be responsible for developing and implementing inventory control procedures, coordinating procedures and practices of Mead's white paper warehouses, standardizing packaging within the corporation, and providing liaison between Mead's operating divisions, Mead Papers, Inc., and Mead merchants in warehousing practices and policies.

As coordinator of central planning, white papers, Mr. Arvold is responsible for the production planning and control and scheduling of the corporation's white paper mills.

Mr. Newton has been associated with Mead in various capacities, all at the corporation's Chillicothe, Ohio, division, since graduation from Rensselaer Polytechnic Institute in June, 1950. Initially he was assigned to the division production manager as an engineering assistant, he was transferred in 1956 to the comptroller's office to assist in the coordination and development of systems and procedures for the Order-Scheduling Dept. One year later he was reassigned to the newly created Operations Service Committee to work on special Division problems. This was the position he held at the time of this promotion.

Mr. Arvold joined Mead Papers, Inc., wholly-owned subsidiary of The Mead Corp., in July, 1957, as a member of



William Newton, The Mead Corp.

Robert P. Arvold, The Mead Corp.

the Dayton staff for the vice-president, sales. Previously, he was associated with the Kimberly-Clark Corp. at Niagara Falls, N. Y., and Neenah, Wis., for six years.

The Mead Corp. has approved plans which will double the size of its corporation research center in Chillicothe, Ohio, at a cost of $1.4 million.

Contracts will be let in September and construction, scheduled to begin in October, will be completed in about one year. Lorenz & Williams, Dayton Ohio, are the architects.

The corporation research center, built originally in 1953, will be enlarged by two extensions to the main building to provide 39 additional offices and 20 new laboratories, and by extending the adjoining pilot plant. This expansion will increase the size of the research center by 46,900 sq. ft.

In addition to the extensions, the main building will be remodeled to provide relocation and enlargement of most of the Mead research groups. The corporation library, photography laboratory, and constant humidity room will undergo the greatest changes. The extension of the pilot plant will provide the much needed space for installation of additional equipment and machinery. One half of the pilot plant extension will have a mezzanine floor. Five offices and seven laboratories in the research center extension will be reserved for research activities of Hurlbut Paper Co., a wholly-owned subsidiary, South Lee, Mass.

Hans Arledter and a portion of his staff will transfer to the Mead Research Center where they will be able to intensify their grade development of specialty papers. To test these developments under actual running conditions, a third experimental paper machine is to be installed in the pilot plant extension.

The laboratories, while located in Chillocothe, serve all divisions of the corporation in searching for ways to reduce the cost of raw materials, improve product quality, improve process efficiency, reduce capital expenditures, develop new products, and supply specialized technical service.

The work at the Mead Research Center is under the direction of R. H. Savage, vice-president, research; R. N. Griesheimer, director; and J. C. Redd, director, new products.

Employees in the department, including 69 scientists, now number 166 men and women. This changing unit will, however, continue to require the addition of an increasing number of people to fill staff positions.

Diamond Gardner

A machine to accurately predict the printability of paperboard has been developed by the Gardner Division of the Diamond Gardner Corp., Middletown, Ohio.

Called the Print Smoothness Tester, the device is essentially a bench model gravure press that includes special design features for testing paperboard. The Tester, a product of four years of research and development, provides a numerical smoothness rating by counting the dot misses through the use of a specially designed template, eliminating the problems of subjective judgment entirely.

Previous indirect smoothness tests bases on air leak or optical measurements lacked the precision to detect commercial quality differences in board.

With the new unit, ink-film remains constant for a series of prints without the need for adding make-up ink. Another advantage is that pressure is obtained by spring or air loading rather than by clearance. No adjustments in pressure are necessary for changes in caliper which adds speed to the operation.

Shipping weight of the unit which is now on the market is 400 lb. The tester is 54 by 25 by 27 in. Additional information and brochures may be obtained from the Gardner Division, Middletown, Ohio.

Print smoothness tester, Diamond Gardner Corp.

Federal Paper Board

Federal Paper Board Co., Inc., a leading producer of folding cartons, has announced that it has purchased for cash the Sweeney Lithograph Co., Inc. of Belleville, N. J.

Terms of the transaction were not disclosed. Sweeney has annual sales of about $\$1^1/_2$ million. William H. Glover, Jr., president of the lithograph company, will continue in charge of the Belleville operations, it was stated.

Directors of Federal Paper Board Co., Inc. voted the regular quarterly dividend of 50 cents a share on the common stock, payable Oct. 15, 1959, to holders of record Sept. 29, 1959. The Board also declared the regular quarterly dividend of $28^3/_4$ cents a share on the 4.6% cumulative preferred stock, payable Dec. 15, 1959, to holders of record Nov. 30, 1959. The retirement of 19,616 shares of the preferred stock, in accordance with sinking fund provisions, was reported by the company.

Western Paper Box

A new expansion of facilities at Stone Container Corp.'s Western Paper Box Division in Detroit has more than doubled the plant's capacity for producing corrugated shipping containers, the company has announced.

The $400,000 expansion, completed since the division moved into larger quarters last December, centers around the installation of a corrugator; a huge machine which combines layers of paper from rolls and turns out flat sheets of corrugated boxboard, from which boxes are made. The new corrugator completes the cycle wherein the Western Paper Box Division can serve its customers through complete processing from roll stock to finished cartons. Previously, Western obtained its board from other Stone plants.

To keep pace with the corrugator's output, the company has also installed additional finishing equipment. The additions include a pair of large two-color printing presses, tapers, and stitchers,and additional die-cutting equipment for special patterns and protective insert pieces. New material handling equipment facilitates the efficient handling of roll stock from the company's own mills.

The 250 ft.-long corrugator (Langston) can handle paper rolls up to 74 in. wide. It has various controls innovations and an all-electronic drive system.

The Western Paper Box Division gained room for the expansion by moving last December into a 158,000-sq.-ft. building at 6400 Harper Ave., which used to be a Packard Motor Car plant. The building, which fronts on Edsel Ford Expressway, provides 50% more space than the Division's former locations.

With the move Western Paper Box put its entire production—corrugated containers, folding cartons and setup boxes—under one roof in a modern one-floor facility.

The Western Paper Box Division employs 205, an increase of 80% since it became a Division of the larger firm.

Stone Container, a major package manufacturer, also operates container plants in Chicago, Philadelphia, and Mansfield (Ohio), carton plants at Chicago (two), South Bend and Franklin (Ohio), and three paperboard mills.

W. H. Kraske

W. H. Kraske has retired after 51 years of sulphite pulp manufacturing experience; the last 42 years in a supervisory capacity. He has worked in Ontario, Quebec, Newfoundland, and in the United States. The last 10 years as supervisor of sulphite, groundwood, and bleaching with the Oxford Paper Co., Rumford, Me. Mr. Kraske plans to reside in Rumford and will be available for consulting on a limited bases.

National Bureau of Standards

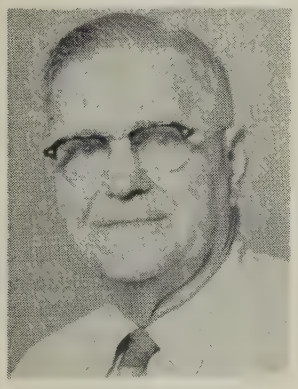
Robert B. Hobbs, of the Organic and Fibrous Materials Division, National Bureau of Standards, has been awarded the U. S. Department of Commerce Silver Medal for Meritorious Service. Dr. Hobbs was cited for "valuable contributions to the science and technology of leather and paper" and for "highly distinguished authorship."

As chief of the Paper Section, Dr. Hobbs supervises research on the fundamental chemistry of cellulose, on the development of methods for measuring the physical properties of paper, and on papers and processes of special interest to other Government agencies, such as currency and postage stamp papers and the lamination of archival documents and military map papers with plastic films.

Dr. Hobbs is a member of ASTM, AMA, TAPPI, ACS, New York Academy of Sciences, Washington Academy of Sciences, Philosophical Society of Washington, and the Federal Club. He has published many technical papers in his field.

U. S. Forest Products

Jerome F. Saeman, 564 Gately Terrace, has been appointed chief of the division of wood chemistry at the U. S. Forest Products Laboratory, Madison Wis, succeeding Dr. Edward G. Locke, 817 Hiawatha Drive, who became laboratory director September 1.



W. H. Kraske

Jerome F. Saeman, U. S. Forest Products Laboratory

Dr. Saeman has specialized in research on lignin hydrogenation, cellulose hydrolysis, and the production and ulilization of wood sugars. During World War II he worked on the development of pilot-plant operations for production of alcohol, molasses, and yeast from wood sugars.

In 1945 Dr. Saeman was a member, with Dr. Locke, of a United States scientific team that spent 5 months in Germany and other European countries, primarily to study German research progress during World War II. For 2 years thereafter he was employed by an Ohio concern that built a plant at Springfield, Ore., to manufacture industrial alcohol from sawdust and other mill wastes.

In his new post, Dr. Saeman has charge of the laboratory's extensive program of research on conversion of wood to useful chemicals, investigations on nitrocellulose and other projects conducted in cooperation with the armed forces, and on fundamental studies of the nature of wood and is chemical components.

L. J. Markwardt, 12 Lathrop St., Madison, Wis., who has managed to crowd the equivalent of three careers into his years of service at the U. S. Forest Products Laboratory, is getting ready to launch a fourth.

Come September 30, Markwardt will retire as assistant director of the laboratory to become a consultant for several industrial concerns in the forest products fields. He will continue to reside at his Madison home. His retirement follows by a month that of his professional associate, Dr. J. Alfred Hall, who was laboratory director for the past 8 years.

Oregon State

James d'A. Clark, chairman of the TAPPI Standards Committee, has been appointed Professor of Pulp and Paper Science at Oregon State College where he will be conerned mainly with graduate and postgraduate research and seminars. A portion of his time will continue to be spent in consulting work, especially in the field of pulps and stock preparation. He will also pursue his interest in the making of papers, felts, and boards by air deposition, and also the manufacture of wafer boards from wood. A large new mill for this process is presently being designed for Saskatchewan. In September, Mrs. Clark and he will move from Victoria, B. C., to Corvallis, Ore., where their address will be P. O. Box 342.

Fiber Products Research Center, Inc.

Two additional Research Associates have been added during the month of August to the permanent staff of the Fiber Products Research Center, Inc., Beaver Falls, N. Y.

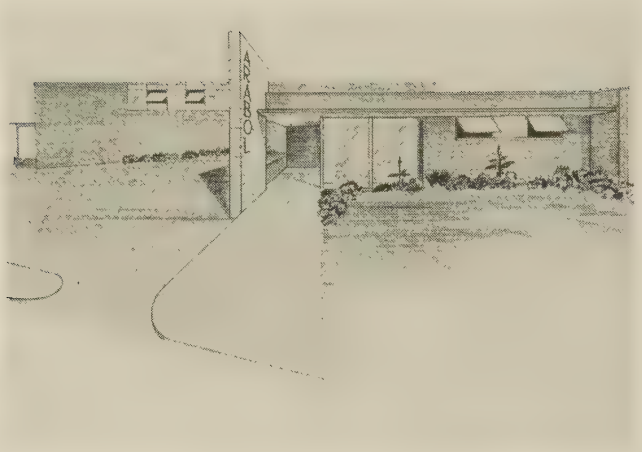
Sidney Bell received his bachelor's degree in 1946 from the University of Texas and completed his master's graduate work at McGill University in 1955. Mr. Bell was a laboratory instructor at McGill University and did similar type of work at Syracuse University.

Albert V. Brucato received his bachelor's degree from Brooklyn College in 1942 and also took graduate work in physical chemistry at the College of the City of New York. He was previously employed by the U. S. Army Chemical Procurement District as an analytical chemist.

Arabol

William A. Weaver, president of The Arabol Mfg. Co. of New York, has announced adhesive the completion of arrangements for a new plant to be constructed immediately in the Cobb-Marietta Industrial Park. The new plant is expected to begin operations in November of this year. Its location affords excellent shipping facilities by rail and truck to all sections of the Southeast.

This development follows a recent announcement by Mr. Weaver of the appointment of Silas I. Wooten as manager,



New plant of the Arabol Mfg. Co.

and William H. Thompson as sales manager for the Southeastern area.

The company's complete line of adhesives covers all operations in paper converting, canning, bottling, printing, packaging, insulation, leather goods, and many other uses. Recently a line of vinyl paints has been added. A new paper size, designed to upgrade paper for better printability and shelf appeal, is a recent result of Arabol research for which equipment will be provided at the new plant.

Borden Chemical

R. J. Lodge, general manager of the Borden Chemial Co., announces the appointment of Arthur H. Haigh as technical representative and James R. McAllister, Jr., as an area sales representative both of the resins and chemicals department. The appointment of Thomas P. Fitzpatrick to the position of Midwest District sales manager for the coatings and adhesives department Co., has been announced by H. L. Schmidt, Jr., general manager, coatings and adhesives department.

Mr. Haigh, who will be working initially in the field of particle board production, was formerly technical director of American Parboard Co. In his former position, he gained experience in plant erection, employee training, flakeboard production, technical sales problems, shipping, equipment, and new product development.

Mr. Haigh received his B.S. degree in Forestry from the Pennsylvania State University in 1940. He is a member of both the Forest Products Research Society and the American Institute of Wood Engineering.

Continuously associated with the wood and woodworking industry since receiving his degree, Mr. Haigh has studied major particle board manufacturing systems in the United States and has also visited plants producing extruded and batch-type board products in Switzerland, Germany, France, Belgium, and England.

He will make his office at the Borden Chemical Co.'s High Point, N. C., Southern District Office.

Mr. McAllister will be responsible for the sale of Borden Chemical's formaldehyde, foundry resins, and wood and paper industry products throughout the state of Virginia.

A graduate of North Carolina State College with a B.S. degree in industrial engineering, Mr. McAllister was previously associated with the wood manufacturing industry specializing in general production, adhesives, and process engineering problems.

He will make his office in Martinsville, Va.

In addition to his new duties as sales manager, Mr. Fitzpatrick will also be responsible for the operation of the company's Chicago plant until those facilities are moved later this year to Illiopolis, Ill.

Mr. Fitzpatrick was formerly technical director of the J. W. Mortell Co. He received a B.S. degree in chemical engineering from Villanova in 1935, and also completed graduate work at the University of Louisville, Franklin & Marshall, and Illinois Institute of Technology.

He will make his headquarters temporarily at the company's Chicago plant.

Arthur A. Coffin, specialist in paper chemistry, has become a consultant for the Borden Chemical Co., it has been announced by W. G. West, sales manager for Borden's Polyco-Monomer Dept.

Recently retired from the Titanium Pigment Corp., a division of National Lead Co., which he served for 29 years, Mr. Coffin is considered one of the nation's top authorities in the paper industry. He will aid Borden's by working with paper manufacturers on applications of the company's full line of synthetic resins and latices. These include butadiene-styrene, acrylic, polyvinyl acetate, polyvinyl alcohol, and other emulsions.

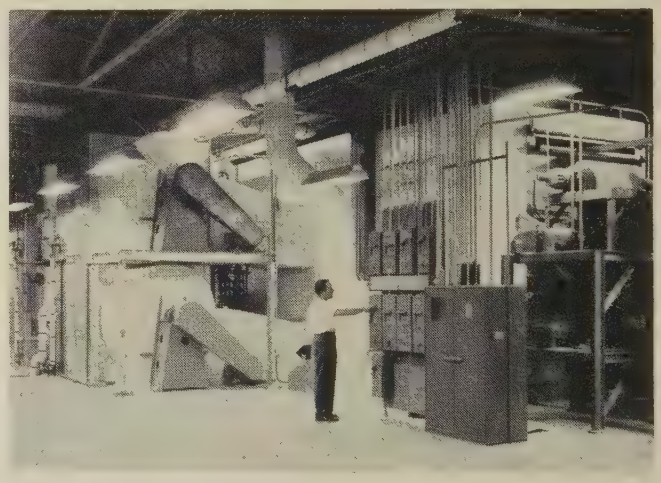
Egan

A 65-ft-long Egan air drier, designed for the treatment of vulcanized fiber, has been installed in the Taylor Fibre Co. plant, Betzwood, Pa.

Constructed by Frank W. Egan & Co. of Somerville, N. J., the unit will take webs up to 75 in. wide at speeds up to 50 f.p.m.

"Relaxed drying" of webs containing 65% water is achieved as the material is guided over the specially designed Egan carrier rolls in the drier's four zones. The first two zones are equipped with humidity controls; web tension throughout the drier is controlled electronically.

Taylor Fibre Co. has installed the pre-drier as part of its capital investment program designed to improve its vulcanized fiber.



Egan air drier

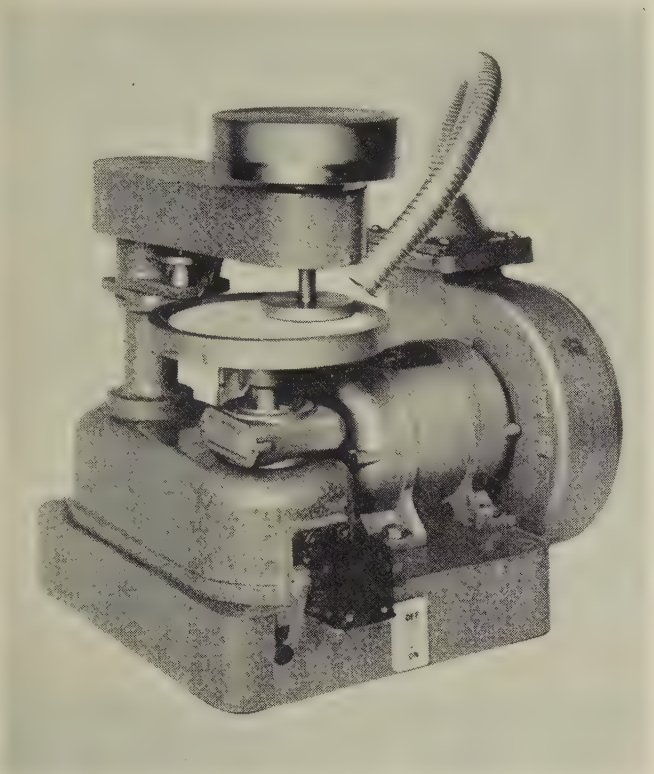
Relaxed drying improves the flexibility and formability of vulcanized fiber. Flexibility is important in applications such as abrasive disks. Ease of formability is required for sporting goods, trunks, cases, and material handling containers.

T. M. I.

A new testing machine developed by the Printing, Packaging & Allied Trades Research Association of Great Britain to measure the rub proofness of print on paper and board is being sold in the United States by Testing Machines Inc. The machine can also measure the transfer of color from printed or coated materials during rubbing (rubfastness), and the abrasion resistance of many plastic materials and leather.

The PATRA rub proofness tester lends itself as an ideal testing medium for investigating, under carefully controlled conditions, new procedures or techniques which involve a rubbing action.

It has two disks which rotate in plane contact at the same angular speed; the pressure between the disks is controlled by a dead weight on the upper one and uniform rubbing is obtained in all directions over the whole surface of the test disk.



Rub proofness Tester

Testing Machines, Inc., announce three brochures covering precision motorized and manually operated dead weight micrometers for the most accurate measurement of paper, film, foil, and rubber sheet materials, according to rigid ASTM and government specifications are also available at T.M.I. Included is an interesting coverage of special purpose instruments for internal and external measurements of moulded pieces, castings, and similar irregularly shaped parts.

A separate sheet illustrates 24 thought-provoking methods for solving difficult and unusual measuring problems.

For complete information write to Testing Machines, Inc., 72 Jericho Turnpike, Mineola, N. Y.

Bowen Engineering

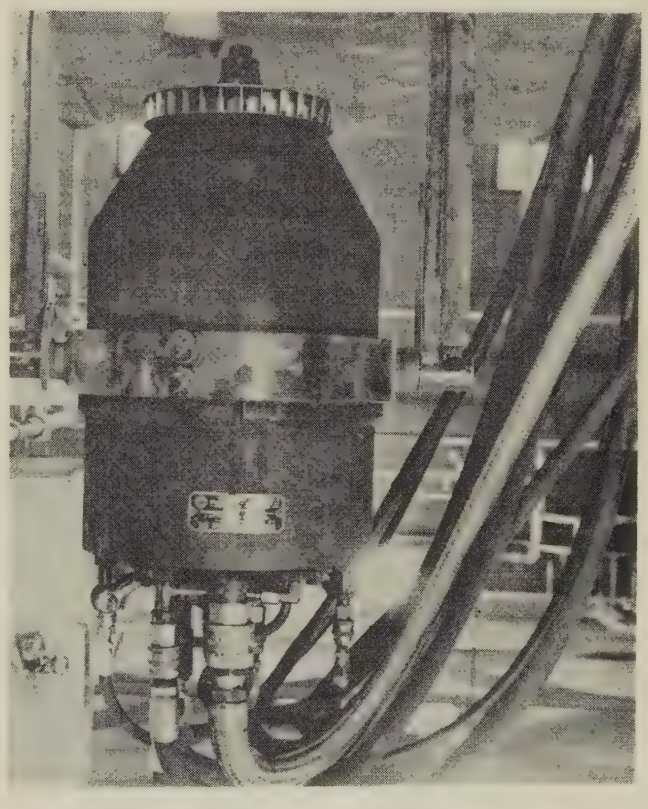
In less than two decades, lignosulphonates have grown from experimental by-products produced in research laboratories to substantial product lines in expanding lignin chemical divisions and subsidiaries of pulp and paper companies. Lignin, comprising 35 to 40% of the dry weight of wood, is separated from cellulose by sulphonation, and, although the chemical properties of the resultant lignosulphonates remain a partially unsolved scientific riddle, they have been found to possess striking dispersion qualities as well as considerable adhesive and binding characteristics.

When compared to other established chemical products and the industries which produce them, lignosulphonates and the lignin industry are very new, with no precedents to follow and many obstacles to overcome. Despite these factors, however, the industry not only seems to be here to stay, but its sharp inroads into the concrete, ceramics, and tanning industries have been so substantial, and its healthy beginnings in varied applications across the industrial horizon have appeared so promising, that the future looks very bright indeed for the youthful industry based on what once was a waste material. Some authorities in lignin products feel that if the uses of lignin continue to grow, such by-products may well become more profitable than their parents, pulp and paper.

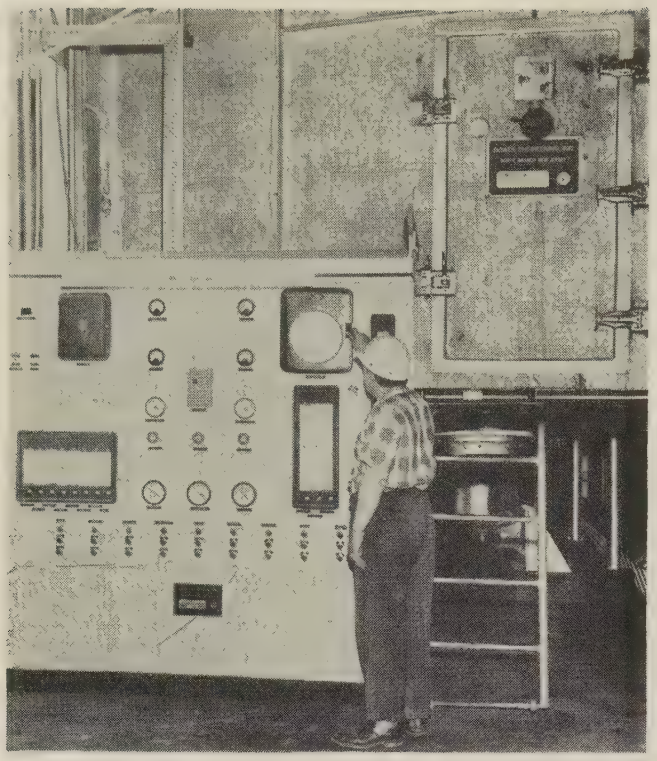
Typifying the zestful, optimistic industry is Lignosol Chemicals, Ltd., a jointly-owned subsidiary of Anglo-Canadian Pulp and Paper Mills, Ltd., and Anglo-Newfoundland Development Co., Ltd. Although Lignosol, as a corporate entity, is less than 10 years old, research activities by parent companies date back to 1943, when a pilot plant for the recovery and study of lignosulphonates was erected in Chandler, Quebec. For seven years, technical and market data were accumulated at the pilot plant, and the facilities gradually expanded into production operations.

In 1950, Lignosol was incorporated and a new plant site, adjacent to the Quebec City mill of Anglo-Canadian Pulp and Paper, was chosen to replace the already inadequate Chandler facilities. The new plant for the manufacture of lignosulphonate products, was completed in 1952. Its operations centered around two spray driers with a total production capacity of 30 tons a day.

The Quebec City plant was built to allow expansion if required. This progressive thinking paid off for the company, for product demand surged so rapidly that, in 1958, Lignosol initiated a million dollar expansion program which ultimately will more than double the original capacity of the Quebec City facilities. The major unit in the expansion was



Closeup of Bowen-patented high speed spray machine, which revolves at approximately 12,000 r.p.m. Note Bowen-patented, 30-vaned, atomizer wheel at base of spray machine, which is used to atomize the liquor slurry at point of introduction



Lignosol employee checks control panel during production run

a 100,000 lb. a day spray drier designed, engineered, and made by Bowen Engineering, Inc., North Branch, N. J., America's only company with activities devoted solely to spray drying technology and engineering and the oldest U. S. firm in the spray drying field.

The spray drier went on stream in March of this year, boosting potential capacity well above the present supply of concentrated liquor. When a second evaporator is completed late this year or early next for the production of concentrated liquors, it will provide enough liquor for the full 80 tons a day which the three driers will be able to produce.

The new 50-ton giant drier, one of only two of its size in the world for the drying of lignosulphonates (both of which were built by Bowen Engineering, Inc.) was chosen by Lignosol even though the two smaller units are those of another manufacturer. The Bowen unit offered Lignosol somewhat larger and more uniform particles, eliminated the problem of a dusty product and offered greater capacity coupled with time, space, and labor savings. It is expected to amortize itself within three years. (The only other lignosulphonate spray drier of Lignosol's size is in operation at Puget Sound Pulp and Paper Co., Pellingham, Wash. It, also went on stream in March of this year.)

Two types of driers were given serious consideration by Lignosol; one with a conical bottom chamber, the other with a flat bottom. Lignosol turned to the Bowen flat bottom design because of its several advantages.

Down time for cleaning, should it be necessary, is minimal in a flat bottom chamber. Furthermore, over-all space requirements for the 24-ft. diam. Bowen flat-bottom chamber spray drier are considerably less than for a similar capacity conical chamber drier which would have required either a higher building or the extension of the operating deck atop the drier through the roof—impracticable in Canada's cold winters. The inplant top operating deck of the flat-bottom chamber unit, where the Bowen-patented spray machine is located, is easily accessible. Another feature inherent in the flat bottom Bowen chamber is its cold air floor sweeper—of great advantage for heat-sensitive materials like Lignosol's.

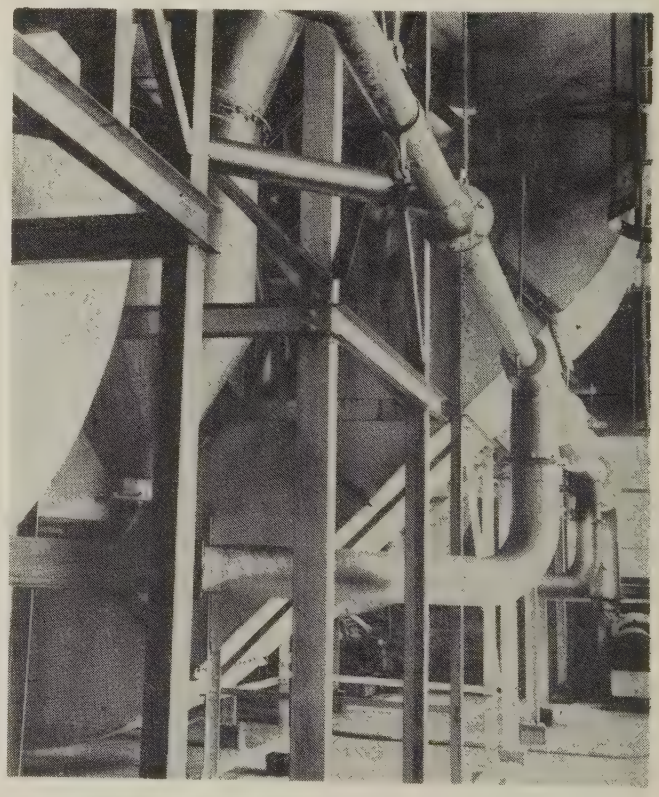
The high frequency, high-speed direct drive on the atomizer assembly was considered by Lignosol to be a substantial improvement over a gear increaser or belt drive (one of Lignosol's smaller driers has a belt drive which has not proved satisfactory). The air heater provided with the Bowen, a compact, space-saving burner with steam atomization of oil, was favored over other heater designs in that it permits faster start up from cold condition than is possible with conventional furnaces, offering a substantial fuel savings to Lignosol.

All spent sulphite liquor, calcium lignosulphonate, is received from the adjacent Anglo-Canadian mill, 100 yards away, by pipeline and is converted by sulphite precipitation to either ammonium or sodium base liquor prior to the evaporation step in which the 50 to 55% slurry to be fed to the spray driers is produced. The flowsheet shows the operation from chipping at Anglo-Canadian through production of spent sulphite liquor to the ultimate bagging of Lignosol products. It is in the spray driers that the spherical end product is produced.

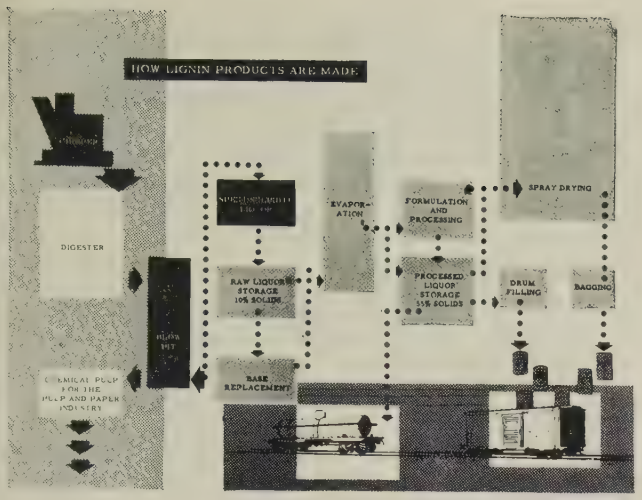
The high-speed spray machine which atomizes the slurry in the drying chamber consists of a high frequency motor with a Bowen-patented, multivaned atomizer wheel of 316 stainless steel mounted on the motor shaft which spins at approximately 12,000 r.p.m. Power is supplied to this spray machine by a frequency converted drived by a 40 hp. motor.

The 50 to 55% total solids feed enters the drying chamber through the spray machine at a rate of from 70 to 140 lb. per min., depending upon the drying conditions required to meet specifications for particular products. Output moisture content ranges from 2 to 4%. Residence time is a matter of seconds—from liquid feed to an end product of predetermined final moisture.

A constant inlet temperature, ranging from an average 500°F. for most slurries to approximately 400°F. for particularly heat sensitive products, is maintained by a temperature controller which acts on the oil supply to the burner. Outlet temperatures range from 250 to 275°F., and are reg-



Collection of the spherical fines from the 50-ton a day spray drier occurs in two Ducon cyclone collectors followed in series by two Dustex collectors. Powder from both sources is conveyed to a central point through the powder cooling piping shown in the foreground of the photograph. Powder collection is almost 100%



Simplified flowsheet of process from chipping of pulp to bagging of lignin products at Lignosol Chemicals Ltd.

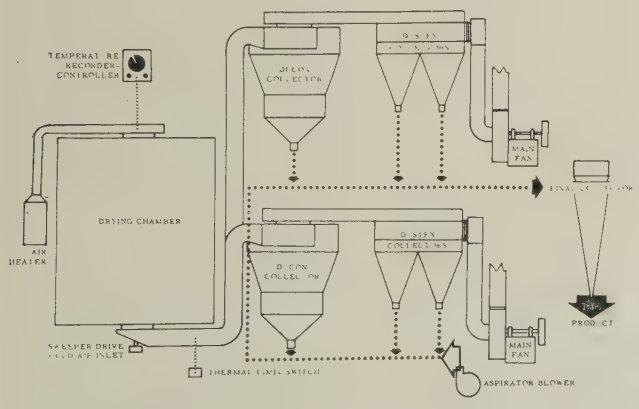
ulated by a similar controller which acts on feed supply. The controls are completely interlocked to assure careful temperature and quality control. Cold air is introduced into the chamber by a Bowen-patented air sweeper to shock-cool the particles. This shock cooling and careful temperature control throughout is of prime importance to Lignosol, for excessive heat, or prolonged exposure to heat, could be deleterious to the lignin product.

The burner which supplies the drying heat uses Bunker C oil. A gas pilot is provided for start up and more expensive domestic fuel oil is required only during warm-up of the driers—just 30 min. for the Bowen unit; 2 hr. for the smaller driers.

The controls which allow careful regulation of the heat generated by this burner, and others which ensure an equally careful regulation of feed rate, enable Lignosol to predetermine end-product particle size and other characteristics.

Lignosol products average 65% retain on 200 mesh. On some products, this drops to 60%; on others it soars as high as 90%. Bulk densities range from 25 to 40 lb. per cu. ft., depending upon product, and pH varies from 4.5 to 6. The hygroscopic Lignosol products range in color from light buff for Lignosol BD (lime base powder) to dark brown for Pellite* products (thinners for drilling muds). All are readily soluble in water. Chemical properties, as previously mentioned, are not yet well defined. Though normally stable at ordinary temperatures, some, like the Pellite product line, are heat sensitive.

In Canada, where 60% of Lignosol's total market is located, lignosulphonates have played an important role in frost heave control and in soil stabilization. The United States accounts for 35% of the market. Other exports account for the remaining 5%.



Simplified flowsheet of spray drying process at Lignosol Chemicals Ltd., Quebec City, Quebec

Applications of Lignosulphonates

Industry	*Applications*
Adhesives	Linoleum cement, resin extender.
Agricultural products	Dispersing agent in wettable powder insecticides and fungicides, fertilizer conditioner.
Cement and concrete	Reduction of moisture content of cement rock slurries, concrete plasticizers and cement clinker grinding aids.
Ceramics	Provides dry strength, improves plasticity, reduces moisture requirements.
Chemicals	Sludge dispersant in boiler feed water treatment, binders for chemical briquettes and pellets, iron sequestrant, foam stabilizer.
Cleaning compounds	Dispersant in industrial cleaners, dispersant in acid cleaners.
Construction	Dustlaying, highway stabilization, treatment of frost heaves, impermeabilization of silts and clays.
Foundries	Foundry core binder, mold wash.
Gypsum	Water reduction in the production of wallboard plaster.
Mining	Briquetting and pelleting, dustlaying in mines, on cars of flotation concentrates, grinding aid where fine grinds are required.
Petroleum	Thinner for lime base drilling muds, contamination resistant thinner for all types of mud.
Refractories	Binder for refractory brick, plasticizer for refractory cement.
Tanning	Pre-tanning vegetable tanned leather, in blends, dry dip, oil wheel compounds, re-tan of chrome-tanned leather.

Lignosulphonates combine irreversibly with protein, which has led to their use in the tanning industry. They are adhesive, which has brought about their use as binders for foundry cores, refractories, briquettes and pellets of various sorts, as well as linoleum cement. They are good dispersants, and this property is most important. It makes possible the use of lignosulphonates in all systems where solids are found in suspension. Current research is primarily concerned with the dispersion properties of the products.

Allied Chemical

Plans to add a liquid aluminum sulphate plant to its Works at El Segundo, Calif., were announced today by General Chemical Division, Allied Chemical Corp.

The Company, which is one of the country's major producers of this widely used industrial chemical, said it will erect the liquid "alum" facilities to meet the demands of paper mills, water companies and other consumers in the Southern California area.

With the completion of the El Segundo unit, General Chemical will have 29 plants producing dry of liquid "alum" in the United States and Canada.

The company's other aluminum sulphate plants on the West Coast are located at Port Chicago, Calif.; and at Tacoma, Vancouver, and Kennewick, Wash.

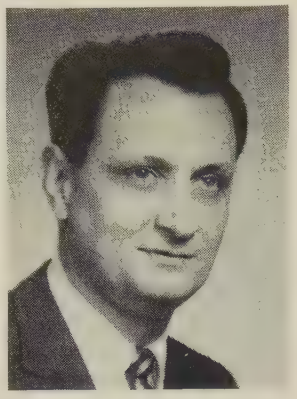
General Chemical has been making dry aluminum sulphate since the turn of the century. It pioneered production and shipping of the liquid product more than a decade ago, primarily to meet requirement of the paper industry which consumes almost two thirds of all the alum produced in the United States. The balance goes into treatment of municipal water supplies and other industrial applications.

El Segundo Works, established in 1920, produces sulphuric acid, aluminum chloride, sodium thiosulphate ("hypo"), and sodium sulphite, among other heavy chemicals. It supplies agricultural chemicals including DDT, parathion, and lime sulphur.

Beloit

Francis G. Ramsden, Beloit Sales Manager, has announced that Robert G. Taber has been appointed an Eastern Representative for the firm.

Taber has been associated with Beloit for 15 years as an engineer and salesman. He will make his home in Chatham, N. J.



R. G. Taber, Beloit Iron Works

Sprout, Waldron

A four-page, illustrated bulletin describing a new type of laboratory refiner has been announced by Sprout, Waldron & Co., Inc., Muncy, Pa. Bulletin 17-B describes the advantages, applications, construction, and operation of a compact single disk swinghead precision-built pulp refiner.

Copies are available on request.

U.S.I.

Three new polyethylene paper coating resins—displaying a marked improvement in adhesion and draw-down characteristics as well as a reduction in neck-in, smoking, coating temperatures, and polymer build-up at the die—have just been developed by U. S. Industrial Chemicals Co. The new resins, which have been field tested and are now commercially available, are designated Petrothene 200–2, 201–2, and 203–2.

Considerable success has been met in extruding these polyethylene resins onto a variety of substrates including paper, paperboard, foil, cellophane, and others. The following chart briefly describes some basic resin properties and recommended applications.

Resin designation	*Melt index*	*Density*	*Recommended coating weights*
Petrothene 200–2	3.0	0.915	20 lb./3000 sq. ft. and higher
Petrothene 201–2	5.0	0.915	10 to 25 lb./3000 sq. ft.
Petrothene 203–2	8.0	0.915	3 to 15 lb./3000 sq. ft.

According to U.S.I.'s Vincent McCarthy, director of Plastics Sales, there has been a fast rise in the use of polyethylene-coated substrates by the packaging industry during the past few years. "Coated paper, cellophane, and foil food pouches, food board for applications such as bakery boxes, and the continuously increasing usage of poly-coated kraft in multiwall bags, and as an industrial barrier material have accounted for most of the growth so far. By 1964 the industry should be using about 95 million pounds of polyethylene annually for coated packages. One large field, polyethylene-coated milk cartons, is still in its infancy. If this market opens up in the near future, the figure of polyethylene usage could easily exceed 100 million pounds per year by 1964," said McCarthy.

Further details of the three new U.S.I. coating resins are presented in a technical data sheet which is available upon request to the company.

Firestone

The Firestone Tire & Rubber Co. Akron, Ohio, acquired an unusual process for the moistureproofing of both natural and man-made fibers, it was revealed today by J. E. Trainer executive vice-president.

The process may find application in the manufacture of a substantial proportion of the paper produced in this country. "It is also believed," Mr. Trainer stated, "that the process may have important applications in the tire, printed electrical circuit board, electrical insulation and molded fiberboard fields."

Negotiations are now under way to make the new process available to manufacturing concerns in various fields on a license basis. According to Mr. Trainer, the process employs a series of unique steps involving treatment of the fibers before impregnating them with various resins. These operations are performed by equipment designed for these purposes.

There is a known demand for paper products having built-in resistance to moisture for use in wrapping and containers of various kinds. In the electrical and electronic fields this development would be applied to insulators and printed circuit board. Molded fiberboard used in many industrial applications would be far more useful when made highly resistant to moisture.

The process is also adaptable to the moistureproofing of glass cloth and other materials used in the aviation and missiles field where absolute freedom from moisture is essential for trouble-free operation of complex electrical and electronic systems.

Bailey Meter

Two-element and single-element air-operated feed water control systems are illustrated by diagrammatic drawings in the new four-page Bulletin 531. To aid in the selection of the proper system for each application, a simplified chart is included. The literature is available from the manufacturer, Bailey Meter Co., 1050 Invanhoe Road, Cleveland 10, Ohio.

Hooker

Several managerial changes have been instituted in the sales department of the Eastern Chemical Division, Hooker Chemical Corp., Niagara Falls, N. Y., it has been announced by John S. Coey, Division sales manager and a corporate vice-president.

William L. Gillespie has been appointed product manager, organic chemicals, succeeding recently promoted Robert B. Boyd. Mr. Gillespie had been manager, sales administration. Succeeding Mr. Gillespie is James S. Walker, formerly manager, technical service. Lloyd S. Bovier, formerly administrative assistant to the director of research, has been appointed manager, market development, a newly created post in the Division's sales department; and Kenneth R. Ewing, formerly a technical service representative, is now supervisor, trichlorethylene. Mr. Ewing succeeds Stanley A. Mattison, now Hooker's Washington manager.

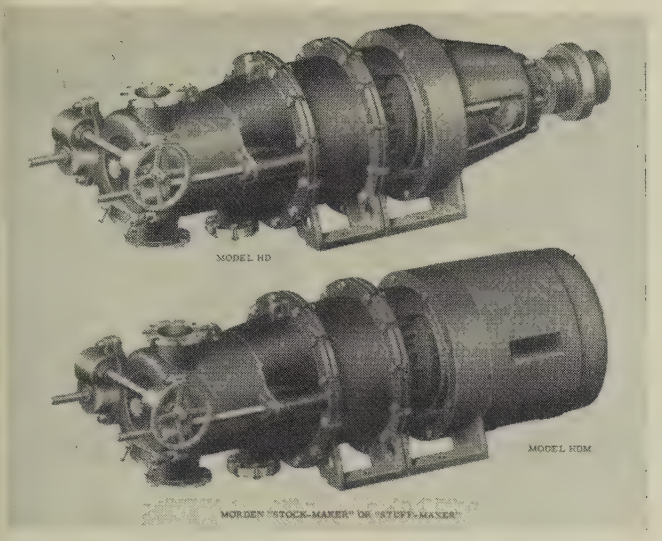
A newly revised products list of "Hooker Chemicals" has just been published by Hooker Chemical Corp., Niagara Falls, N. Y., and is available free upon request.

The new bulletin, No. 100-C, contains brief descriptions, physical data, uses, and shipping information on many chemicals listed. Chemicals manufactured by Hooker's Phosphorus Div. are separately listed and described in a new two-page supplement which is also available.

Morden Machines Co

R. B. Honeyman, vice-president of Morden Machines Co., Portland, Ore., has announced the development of the new HD and HDM "Stock-Maker" refiner and "Stuff-Maker" jordan.

Morden's creative engineering has improved and simplified their design to give a 20% reduction in initial investment. The introduction of the new two-piece rotor and shell filling has reduced the cost of replacement fillings. The new



Morden "Stock-Maker" or "Stuff Maker"

"Stock-Maker" retains the same principles of reverse-flow sealed-pressure heating treatment. A simple filling change in the "Stock-Maker" converts it to a "Stuff-Maker" with standard jordan flow for cutting treatment. The unique feature of the integral motor arrangement is optional and reduces space requirements and maintenance problems. Fillings may be changed in two hours or less and down time is at a minimum compared to most conical refiners. Fillings are precision machined, thus eliminating the necessity of grinding-in. Fillings are dynamically balanced to assure uniform wear. There is interchangeability of fillings between the new model and existing "Stock-Makers" in the field. Improved metallurgy has provided a more versatile selection of fillings for all types of treatment.

The new "Stock-Makers" and "Stuff-Makers" will be available in two sizes. The No. 6 size employs a 150 to 200-hp. motor and the No. 8 size has a 300 to 350-hp. motor.

Modern designs stock preparation systems for all grades of paper. Their systems also include the "Slush-Maker" pulper with its attrition defibering principle. Morden machines are in service in nearly 300 mills throughout the world and they have more than 1000 "Stock-Makers" and "Stuff-Makers" in operation.

Carborundum

KT silicon carbide, a self-bonded, impervious form of silicon carbide recently developed by The Carborundum Co., has operated 1700 hr. in a highly corrosive application where previous materials lasted only 48 to 75 hr. at best.

The Barrett Division of Allied Chemical Corp., Dubuque, Iowa, produces structural board for the building trade. Continuous digestors, or pulpers, in operation at Dubuque work with soda-base liquor under 150 p.s.i. steam pressure. In the last stage of the digestor, an impeller accelerates the pulp slurry through discharge valve assembly into a wear sleeve. After passing through the wear sleeve the slurry is expanded and blown into cyclone storage tanks. The wear sleeve was the trouble spot of excessive corrosion. Although the normal operating cycle is 240 hr. the steel alloy wear sleeves previously used had to be replaced after 48 to 75 hr. thus incurring excessive replacement and down time costs. A wear sleeve of Carborundum's KT silicon carbide operated 1700 hr., or more than 20 times the life of the super steel alloys used previously. Replacement cost was reduced 80% in addition to the more significant savings resulting from the elimination of repeated machine down time.

Performance of KT silicon carbide as apex disks in iron ore beneficiation processes is another example of its unusual wear-resistance properties. These disks are pounded by a $^1/_8$ in. diam. taconite ore slurry at approximately 20 tons per hr. Placed in operation at the beginning of the 1957 ore season, after 2500 hr. of use, the KT silicon carbide disk showed no signs of wear. The best metal alloy apex disk lasted on an average only 24 to 36 hrs.

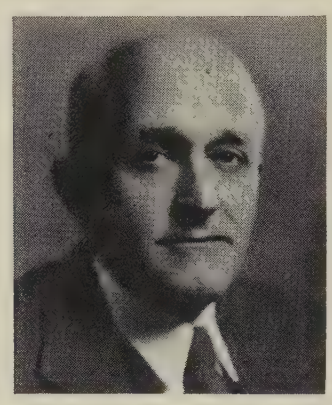
The unique structure of KT silicon carbide is the primary reason why it outwears metal alloys on these highly corrosive operations. Approximately 97% pure silicon carbide, self-bonded and free from weakening interstices which would otherwise be present with secondary bonds, the surface silicon carbide molecules constitute a tight abrasion-resistant lattice of chemically inert, impervious silicon carbide.

KT silicon carbide can be formed into practically any shape common to standard ceramic techniques. Dimensional tolerances in the unground condition can be held to ±0.010 in. Surface finishes can be obtained as low as 5 micro in., by diamond grinding.

For further information, write to: Advertising Branch (PJE19), The Carborundum Co., Niagara Falls, N. Y.

Singmaster and Breyer

J. W. Hemphill, formerly of the Johns-Manville Sales Corp. and of Carthage Machine Co., has joined the sales staff of Singmaster & Breyer, Inc., New York, chemical process and metallurgical engineers, as a pulp and paper specialist.



J. W. Hemphill, Singmaster and Breyer, Inc.

This move marks Singmaster & Breyer's entry into the pulp and paper field. The firm, which has had years of experience in the development of first-of-its-kind plants requiring a high degree of process engineering competence, is an affiliate of The Fluor Corp., Ltd., of Los Angeles.

Diamond Alkali

Diamond Alkali Co., International Division, announces the publication of *Diamond Chemicals for Industry.* This catalog comprises 75 pages and covers 200 chemicals produced at Diamond's 15 plants.

Convenient cross references and indices are used to enable the chemical buyer to determine various applications in 30 industries. Each product is completely described with analyses and data showing suggested usage. The book is available on request to: Diamond Alkali Co., International Division, Department IND, 99 Park Ave., New York 16, N. Y.

Hubinger

The Hubinger Co., Keokuk, Iowa, manufacturers of OK Brand starches, recently announced two changes in their organization which will further expedite service to corrugators and paper mills.

Carroll Taylor, Paper Mill & Corrugating Technical Service representative, was transferred from Keokuk, Iowa, to Dayton, Ohio, so that faster, more effective service may be offered to the company's customers in that area.

A new position, "Manager of Paper Mill Sales," was created as a means for strengthening the entire range of services being rendered to paper mills. Howard Peper, long a Hubinger sales service representative, has been appointed to this position. "Pep" will continue to make his headquarters in Chicago, Ill.

GOODYEAR

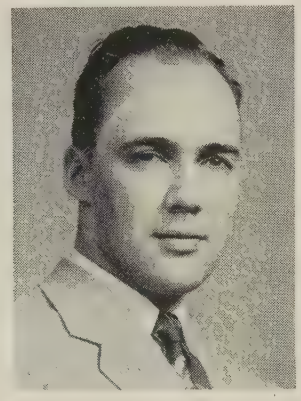
A major realignment in the field sales organization of The Goodyear Tire & Rubber Co.'s Chemical Division has been announced by C. O. McNeer, general sales manager of the division.

Those affected by the changes include L. E. Stanton, R. W. Williams, J. Platner, and J. D. Hunter. Following closely the creation of two new sales departments within the division, these shifts were made to continue and expand the Chemical Division's sales representation in all of the nation's major market areas, McNeer said.

Mr. Stanton, former district manager at Houston, has been transferred to Detroit as district manager, replacing L. P. Thies who recently was named manager of the new Polyester Products department.

Mr. Williams, former senior sales representative on the West Coast, has been appointed West Coast district manager. In this position, he will have his headquarters in Portland and also maintain offices in Los Angeles and San Francisco.

L. E. Stanton, Goodyear Tire and Rubber Co., Chemical Division



R. W. Williams, Goodyear Tire and Rubber Co., Chemical Division

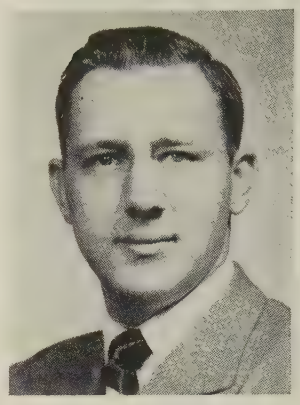
Mr. Platner, replacing Stanton, has been appointed district manager at Houston. He was formally senior sales engineer in the Rubber and Rubber Chemicals department.

Mr. Hunter, former senior sales representative in the division's Chicago office, has been transferred to the St. Louis office as district manager. He replaces W. E. Kelly who recently was named manager of the division's new Adhesives Department.

Mr. Stanton came to Goodyear in 1954 with previous experience in the rubber and chemical industries. He was assigned to Houston as special representative and appointed district manager there in 1958. In his new post, he will be responsible for sales in the Detroit area and parts of Canada. He received a B.S. degree in Chemistry from Elmhurst College, Ill., and is a member of the ACS., the Southern Rubber Group, and the Dallas Paint and Varnish Production Clubs.

Mr. Williams joined the Goodyear Chemical Division in 1953 as a special representative and was transferred to the Portland office soon after. He attended Reed College in Portland and before joining Goodyear was a chemical engineer in the lumber industry in Washington.

Mr. Platner joined Goodyear in 1947, was assigned to the Research Division in 1948 and the Chemical Division in 1953. He was senior sales engineer in the Coatings Department until being tranferred to the Rubber and Rubber Chemicals Department early this year. He graduated from Heidelberg College with a B.S. degree in Chemistry and received a M.S. degree from University of Akron. He is a



J. Platner, Goodyear Tire and Rubber Co., Chemical Division

J. D. Hunter, Goodyear Tire and Rubber Co., Chemical Division

member of the ACS and the Akron Rubber Group.

Mr. Hunter has been with the company since 1953. Experienced in the fields of research and development, he was assigned to the Chicago district. A graduate of Notre Dame University with a B.S. degree in Chemistry he is a member of the ACS, the Chicago Rubber Group, and the Paint and Varnish Production Club of Chicago.

HERCULES

Hercules Powder Co. has disclosed it is sponsoring a $500,000 program, under which a basic study would be made of the toxicological properties of chemicals which Hercules supplies to the food packaging industry.

The program, developed with the guidance and cooperation of the Food and Drug Administration, will be conducted by the Industrial Bio-test Laboratories, Inc., Northbrook, Ill., and will have two phases: The first, covering acute and subacute toxicological studies; the second, to be concerned with chronic toxicological studies ranging up to three years in length.

The results of this study will be available to aid customers in their compliance with requirements of recent amendments to the Food and Drug Act.

The initial program is estimated by Hercules to cost about $500,000, but continuing studies will add considerably to the total cost in the years ahead.

The chemical materials to be covered in the study have been used by the food packaging industry and others for years—in some cases for more than 100 years.

"Safety to the consumer in any of these products has never been questioned, but under the new FDA law, safety must now be formally proved in accordance with exacting and detailed specifications of the law if use of these materials is to continue," pointed out Paul Mayfield, vice-president of Hercules. He cited adhesives as an example, of which there are now approximately 700 different formulations in use by the paper and packaging industry.

"Ever since the first paper bag was made and used to package the family groceries, adhesives have come in contact with food without any apparent harm to the consumer. Under the new FDA regulations, however, proof of harmlessness must be definitely established to permit continued use of these materials in food packaging," Mr. Mayfield said.

Hercules markets over 50 types of resins that may become unintentional food additives under the food additives amendment. These include basic rosins, modified rosins, aducts, salts, and esters. All these products find wide use in the food packaging industry—in paper, can coatings, coatings for paper, cellophane and foil, rosin size, adhesives, and printing inks.

Most of the chemical materials under study by Hercules

come in contact with food only as ingredients of packaging materials. Some of these chemicals, under certain conditions, can "migrate" from the package to the food; in most cases in amounts so small that radioactive tracer techniques are required to detect such migration.

Experience, based on the long history of the use of these chemicals without known injury, would attest to their essential safety. Nevertheless, even though essential safety has been unquestioned historically, it is Hercules' intention to provide users of these chemical materials with basic toxicological data which the FDA has indicated it will require for compliance with the law.

Arnold, Hoffman

"Sedomax F," a polyelectrolyte developed by Imperial Chemical Industries Ltd., brings about good flocculation and quicker settling of finely divided solids in aqueous suspensions. It is being introduced to the American papermaking industry by Arnold, Hoffman & Co., Inc., I.C.I. subsidiary.

Sedomax F is a light-colored, viscous liquid readily miscible with water; both the liquid and its dilute solutions are very stable and do not deteriorate in storage. Although effective in the pH range 5 to 10, Sedomax F is most effective under alkaline conditions; it may be added advantageously during pulp and paper manufacture at the following points: process water treatment, green liquor clarification, bleach liquor settling, white water clarification, retention of fines.

Further information on Sedomax F is available from Arnold, Hoffman & Co., Inc. at Providence, R. I.

Olin Mathieson

The application of C2, a sodium chlorite product, to control slime in paper mills has proved successful, it was announced by the Chemicals Division, Olin Mathieson Chemical Corp.

Test results—obtained in cooperation with several paper manufacturers through carefully controlled programs of laboratory testing, pilot tests in single machines and full scale use—indicate that this product is one of the most effective slime killers available for acidic white water systems. Its slimicidal action is based upon the slow release of chlorine dioxide which is generated continuously throughout the entire white water system.

This maintained action is a distinct advantage over slimicides which function only near the point of application. In addition, C2 causes no foaming at the headbox or darkening of the pulp and, at the recommended level of use, has caused no detrimental effects on dyes.

A new data sheet, "C2 for Slime Control in Paper Mills," just published by Olin Mathieson, gives information on the application, storage, and handling of the slimicide. It also includes charts on the rate of chlorine dioxide release, the solubility of C2 in water and the specific gravity of aqueous C2 solutions.

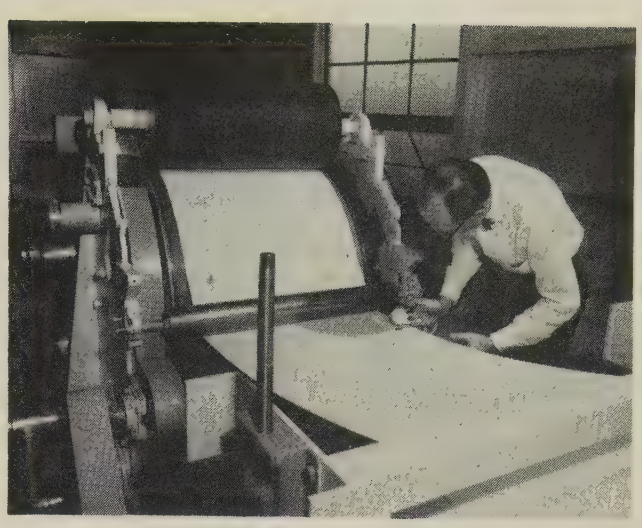
To obtain a copy of the data sheet and further information on C2, write to: Market Development Dept., Chemicals Division, Olin Mathieson Chemical Corp., Baltimore 3, Md.

Dewey and Almy

The appointment of Dr. Krishna K. Khandelwal of Waltham, Mass., as senior development engineer in the Darak Battery Separator Laboratory, Dewey and Almy Chemical Division, W. R. Grace & Co., Cambridge, Mass., has been announced by John R. Thomas, laboratory manager.

Dr. Khandelwal who comes from the Rice Barton Corp., Worcester, Mass., has also erved with the Syracuse University Research Institute, the Champion International Paper Co. and the Iowa Institute of Hydraulics Research.

A native of Calcutta, India, Dr. Krishna attended St. Xavier's College, Calcutta University, for two years, then came to the United States where he received a B. S. in Chemical Engineering at the State University of Iowa in 1950, an



Caliper of sheet from Rotoformer papermaking machine in Dewey and Almy's new Polyfibron (polymers-fibers) Laboratory is measured by C. Berk Moore, in charge of paper making and impregnation studies

M. S. in Pulp and Paper Technology from the University of Maine in 1951, and a Ph.D. from Syracuse University in 1956.

He is a member of the A.I.Ch.E., ACS, TAPPI, Alpha Chi Sigma, Phi Lambda Upsilon, and Sigma Xi. He is secretary of the TAPPI Engineering Division's Drying Committee.

A Polyfibron Laboratory with fully integrated pilot-scale facilities for making, impregnating, and coating papers is nearing completion at the Cambridge, headquarters Dewey and Almy.

Most of the planned equipment is already in use by researchers for (1) pulp treatment paper forming, drying, and calendering; (2) impregnation by beater addition, wet saturation, and dry saturation; and (3) the application, drying, and testing of paper coatings, announced Russell L. Haden, Jr., general manager of Battery, Polyfibron, and Textile Division.

Haden said the name "Polyfibron" (polymers-fibers) describes "Dewey and Almy's unique combination of experience and skills in two technologies, the knowledge of polymers and of the fibers in formed webs which are impregnated and coated with certain of these polymers."

The pilot laboratory is expected to accelerate Dewey and Almy's improvement of its existing impregnated fiber products and its explorations into new fields, said Haden. Existing products include insoles; welting; and sock lining, heel pad, and counter materials for the shoe industry; plumper materials to increase firmness of leather and fabric accessories; coating bases for manufacture of artificial leather and other finishes; and automotive battery separators inserted between the plates of lead-acid storage batteries.

In addition to impregnating equipment, the laboratory also contains complete pilot equipment for paper-coating studies both by Polyfibron and by Dewey and Almy's Organic Chemicals Division in the research of butadiene styrene, polyvinyl acetate, and other emulsions used as paper coating binders. Organic Chemicals Division will operate the laboratory's paper coater (equipped for roll, trailing blade, and air-knife coating), drier, and controlled humidity testing room containing a Vandercook proof press and other testing apparatus.

Facilities in the new laboratory, a remodeled and enlarged building in Dewey and Almy's main laboratory area, are arranged in a flexible two-story layout to accommodate a wide range of research projects. A special feature is the use of a Varidyne alternator to supply current to synchronized motors on the papermaking line. The motors can be individually varied from the base speed to compensate for shrinkage of the sheet as it passes down the line.

Dewey and Almy, which started 40 years ago this year as a manufacturer of specially compounded rubber-sealing compounds, pioneered in the polymerization of synthetic rubbers and polyvinyl acetate emulsions in the late '30's, and since the early '30's has developed specially-formed fiber stocks and impregnated them for shoe products and a variety of end uses. These products are individually engineered to possess such required properties as high tensile and internal strength, stretch, and tear-fold as well as water-grease resistence.

Long a supplier of polymers to the paint, textile, and adhesive fields, Dewey and Almy has recently entered the paper coating field with their introduction of two binders, a vinyl acetate copolymer emulsion for food wraps, and other applications where freedom from odor and grease resistance are important, and a butadiene styrene latex for coating high quality printing papers.

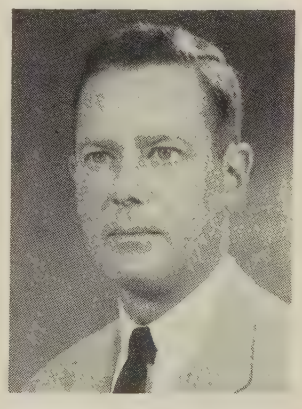
Manager of the Polyfibron Laboratory is Ralph L. Wentworth. Papermaking and impregnation studies are supervised by C. Berk Moore of the Battery, Polyfibron and Textile Division. Robert F. Avery of the Organic Chemicals Division is in charge of the paper-coating research facilities.

The laboratory represents the second time in recent months in which the same two divisions of Dewey and Almy have pooled their common interests to establish joint facilities. In June the divisions dedicated a new plant at Owensboro, Ky., to manufacture butadiene styrene copolymers latices, polyvinyl acetate emulsions, and battery separators. The building occupied by the new laboratory originally housed the country's first pilot plant for GRS synthetic rubber in the early days of World War II. Dewey and Almy was the first in America to establish a privately owned plant for the butadiene-styrene type of synthetic rubber on which the government later standardized for all wartime synthetic rubber manufacture.

Combustion Engineering

D. S. Walker, vice-president and director of sales for Combustion Engineering, Inc., has announced the appointment of Vincent P. Owens as assistant general sales manager in charge of Industrial Products. For the past 10 years Mr. Owens has been manager of Paper Mill Equipment Sales. He will continue to supervise the Company's Paper Mill Division sales in addition to sales of Industrial Steam Generators, Raymond Division equipment and Fabricated

V. P. Owens, Combustion Engineering, Inc.



E. L. Smith, Combustion Engineering, Inc.

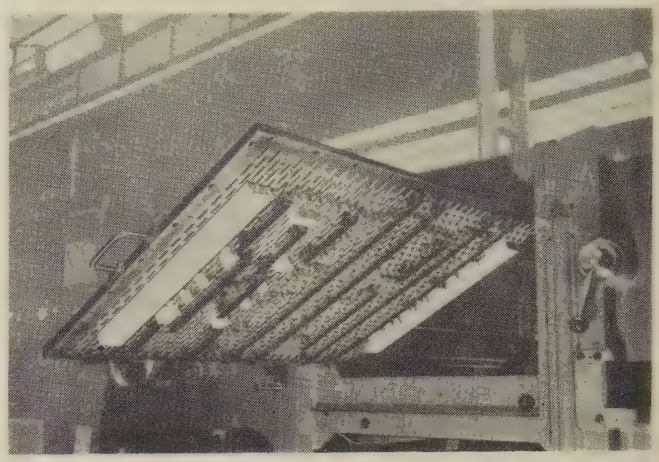
Products. Mr. Owens has been continuously active in paper mill circles since joining the Combustion organization in 1936.

A mechanical engineering graduate of New York University, Mr. Owens is a member of TAPPI and ASME and is currently Secretary of the Engineering Division of TAPPI.

As successor to Mr. Owens, E. L. Smith has been appointed manager of Paper Mill Equipment Sales.

Thompson National Press

Automatic high-speed stripping of interior and exterior waste is available on the famous Bobst Die Cutting & Creasing Autoplatens distributed by Thompson-National Press Co., Inc., Franklin, Mass.



Bobst pull-out male stripping case showing various wood and steel stripping make ready

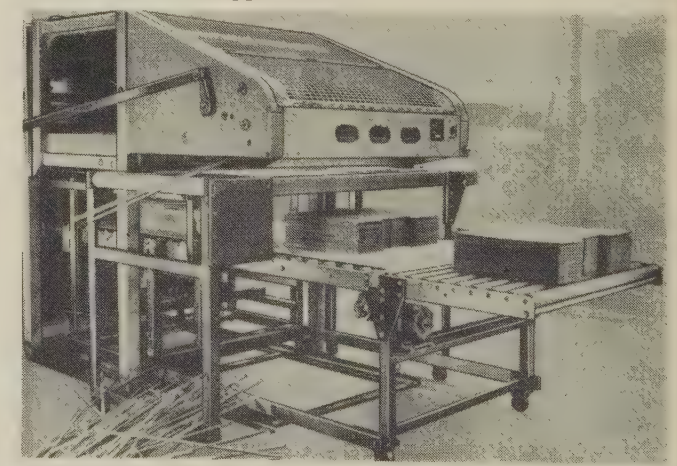
Bobst presses are available for either folding box (SP series) or corrugated-solid fiber (SPO series) die cutting. Single Stripping Station models automatically remove all interior and exterior trim except the leading gripper edge. Double Stripping Station models deliver a completely finished sheet ready for packing.

Full press speeds of 4500 sheets per hr. are possible on single Stripping Station models of the folding box presses and 30 × 42 models of the corrugated-solid fiber presses. Speeds up to 3600 sheets per hr. can be attained on the larger 42 × 62 corrugated presses with either one or two stripping stations.

The Bobst stripping system may utilize inexpensive, plywood male and female dies as well as the more conventional slotted and plexiglas chases. Stripping dies provided with the press can be removed from the press and replaced in perfect register. Front, side and interior waste down to $^{3}/_{32}$ in. slots and $^{3}/_{16}$ in. diam. holes may be automatically stripped without a reduction in speed.

The stripping Stations of the press are readily accessible and can be by-passed quickly and easily when stripping is not required. Fast, simple makeready and inexpensive plywood stripping dies make Bobst Autoplatens ideal for long or short runs on all types of stripping jobs.

Over 60 Bobst presses with strippers are now running in the United States. Container Corp. of America is now operating five of the larger corrugated and solid fiber machines with two strippers each.



Automatically stripped cartons being counted onto conveyor by Bobst press

THWING-ALBERT

Bulletin 321-BW, describing their wall basis-weight scale is available from the Thwing-Albert Instrument Co.

In addition to a comprehensive outline of the uses and features of the scale, this bulletin describes in detail the exclusive multirange instrument dial.

Copies may be obtained by requesting Bulletin 321-BW from the Thwing-Albert Instrument Co., Penn St. & Pulaski Ave., Philadelphia 44, Pa.

PATTON MFG.

Patton Manufacturing Co., paper mill machinery-building firm of Springfield, Ohio, has announced the development of a horizontal smoothing press and breaker press which represents an entirely new approach in smoothing press design.

The development of the new Patton Horizontal Smoothing Press is as unconventional in engineering approach as was Patton's approach to size press design two years ago when the firm pioneered the horizontal size press.

A Patton Horizontal Smoothing Press has already been installed in a large Eastern paper mill where operation reports indicate that the unit offers a number of specific economic advantages.

The Patton Horizontal Smoothing Press has been designed for installation in paper-machine drier sections at approximately the same position where a horizontal size press is now usually located. The horizontal smoothing press can be converted to a horizontal size press by the simple expedient of changing from two hard rolls to one hard and one rubber covered roll. In essence, this means that Patton Horizontal Size Presses can now be changed to smoothing presses by simply substituting a chilled iron (usually water-cooled) roll commonly used in smoothing presses on paper machines.

This roll change and interchangeability factor gives rise to a number of entirely new possibilities, according to Patton engineers. Initially, however, Patton points to the need to clarify "smoothing press," "breaker press," and "breaker stack" nomenclature because many mills use these terms interchangeably when such equipment is used immediately ahead of the size press.

The new Patton Horizontal Smoothing (or Breaker) Press makes it possible to arrive at an entirely new approach because the installation of two horizontal units in sequence will make it possible to use either unit as a smoothing or sizing press. This will in effect result in such possible usage combinations as (1) double sizing; (2) a double breaker operation, or (3) the more conventional breaker-followed-by-surface-application operation.

HUYCK FELT

Huyck Felt Co., Rensselaer, N. Y., and Aliceville, Ala., announces the appointment of James E. Stanley to the position of Felt Sales Engineer for Virginia, West Virginia, and portions of Tennessee and North Carolina.

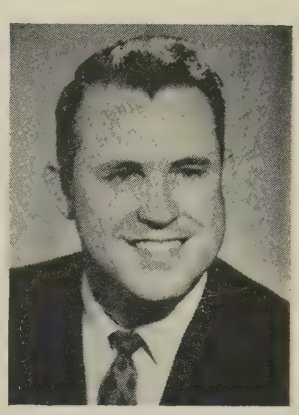
Mr. Stanley is a graduate of Lowell Institute of Technology and has considerable industrial fabric experience. After joining Huyck in 1955 and working in all phases of felt design and manufacture, he served for three years as a jet pilot with the Air Force. Following this tour of duty he resumed his training at Huyck's Rensselaer plant and at paper mills throughout the United States.

WALWORTH

Walworth Co., a leading valve and fitting manufacturer, announced the recent appointment of Robert Conway to the position of Manager of the firm's Southeastern Division. In his new duties, Mr. Conway will be responsible for Walworth interests throughout seven states, and parts of two others.

Mr. Conway a graduate of Louisiana State University, has been with Walworth seven years and has served as Northwestern Division Manager and Pulp & Paper Mill Sales Manager.

James F. Stanley, Huyck Felt Co., Rensselaer, N. Y.



Robert Conway, Walworth Co.

SANDOZ

The transfer of Robert Welsh from a dyestuff sales assignment in the Philadelphia territory to Pacific Northwest area has been announced by Mr. A. T. Hanes, vice-president and marketing manager for the Dyestuff Division of Sandoz, Inc.

Mr. Welsh started with Sandoz as a trainee in 1948, after graduating from Cornell University. A veteran of World War II, he left Sandoz in 1950 for Korean service as a First Lieutenant in the U. S. Marines. He then joined the James Hunter Machine Co., selling textile machinery in the middle Atlantic states.

In 1958, Mr. Welsh returned to Sandoz as a dyestuff saleman reporting to the Philadelphia District office. He is a member of the American Association of Textile Colorists and Chemists.

I.T.E. CIRCUIT BREAKER

Detailed information on its complete line of electromagnetic clutches in six series with torque capacities from 1.8 to 13,000 lb-ft., is furnished in a new bulletin published by I.T.E Circuit Breaker Co., Philadelphia.

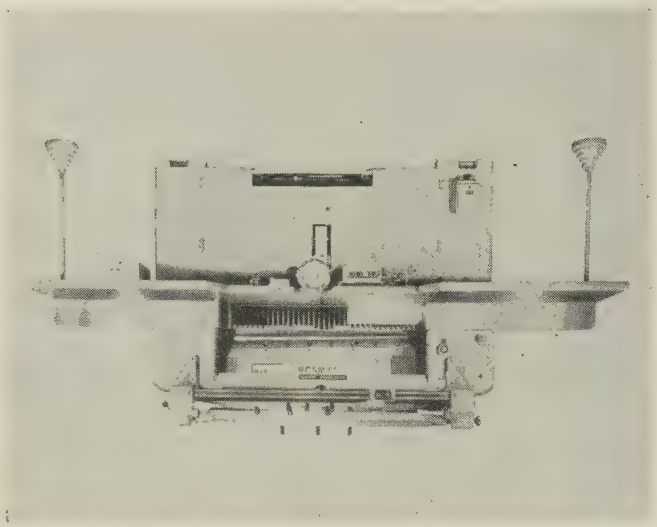
The 20-page bulletin provides design, specification and application material, including photographs, drawings, and sketches, to assist machinery designers and application engineers. The I.T.E Electro Clutches provide instantaneous pushbutton or automatic programming control of shaft-driven machinery in a variety of fields. Applications include such machine tools as grinders, drill presses, boring mills, milling machines and lathes; such general equipment as industrial washing, pulverizing, printing and packaging machinery; and specialized equipment including conveyors, welders, wind tunnels, radar antennas, test equipment, and nuclear control mechanisms.

Copies of the new bulletin, R-6304-1B, may be obtained from I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

LAWSON CO.

Fifty stroke-a-minute heavy duty hydraulic clamp cutters in 46, 52, and 55-in. sizes have now been added to the popular Lawson Pacemaker line, according to Carlton Mellick, Director of Sales of the Lawson Co., Division of Miehle-Goss-Dexter, Inc.

In addition to their outstanding knife speed, said to be nearly 20% faster than that of any other comparable machines, the new cutters are the first in their size range to incorporate all of the modern design advantages of the productive 60, 66, and 69-in. Lawson Pacemakers.



The Lawson Pacemaker

Among the new features of special interest to the trade are: rear table slot closing device to facilitate rear loading or "swinging" the lift; true two-end knife pull utilizing a unique-double crank design; three-point knife bar support to prevent bowed or concave cuts; and newly engineered double overload and nonrepeat safeties. Available as optional equipment are Lawson's air cushion device, an adjustable flexible Contour Clamp that compensates for surface irregularities produced by ink build-up or the nature of the stock itself, and Lawson's Electronic Spacer that is said to automatically move a lift through a complete series of cuts and trim-outs with 0.002 in. accuracy.

The new Lawson 46, 52, and 55 in. Pacemaker cutters incorporate truly cushioned hydraulic clamping pioneered and shop-proved by Lawson in thousands of installations throughout the world. The sturdy 5 in. wide clamp descends under minimum pressure so as not to mar top sheets. Pressure instantly builds up to hold the paper firmly in alignment throughout the cutting cycle. A special pressure interlock system prevents the knife from starting to cut before full preselected clamping pressure has been applied. The adjusting knob and pressure gage are at eye level, on the front of the machine, for the convenience of the operator. The extra large hydraulic fluid reservoir is cast right into the base of the cutter.

Additional details may be had by writing directly to The Lawson Co., 2011 Hastings St., Chicago 8, Ill.

Electric Storage Battery

Joseph A. Snook, president of The Atlas Mineral Products Co., Mertztown, Pa., and Murray H. Bennett, president of Chemical Linings, Inc., Watertown, N. Y., have announced that agreement in principle has been reached whereby all of the capital stock of Chemical Linings, Inc. will be acquired by The Electric Storage Battery Co., Philadelphia, of which Atlas is a wholly-owned subsidiary. The consideration will be common stock of ESB. Settlement is expected early in October.

Under its new ownership, Chemical Linings will be supervised by Atlas, but its present management will be retained.

Chemical Linings designs, fabricates, and installs corrosion-resistant linings, tanks, towers, etc. for process industries, primarily pulp and paper.

Babcock and Wilcox

F. H. Foglesong has been named to the newly created position of manager of alloy sales for the company's Tubular Products Div. Mr. Foglesong will make his headquarters at the division's general offices in Beaver Falls, Pa.

A. D. Zar, formerly sales representative in Milwaukee, Wis., district office, succeeds Mr. Foglesong as manager of the division's Detroit district sales office.

The Tubular Products Div. has prepared a folder entitled "How to Cut Cost by Using Alloy Mechanical Tubing."

The folder discusses initial cost, structural advantages of tubing, fabrication by machining, types of steel, types of tubes, and procurement tips.

Copies of the four-page folder, TB-430, may be obtained from the Division's sales headquarters at Beaver Falls, Pa.

Shawinigan Resins

Production of a new borax stable polyvinyl acetate-dibutyl maleate copolymer emulsion has been announced by Shawinigan Resins Corp.

Designated Resin D-243, the emulsion is said to be unique because it combines borax tolerance with a high degree of compatibility with organic solvents. The product has a particle size distribution of from 0.2–1.5 μ. In addition, the resin is reported to have superior flow characteristics, excellent freeze-thaw, and mechanical stability. Films cast from the new resin have the advantages usually associated with internal plasticization such as improved film forming characteristics and low temperature flexibility without the need for additional plasticization.

Resin D-243 is suggested particularly for use in adhesives, in textile finishing, as a cement additive, in paper coatings, surface coatings, and as a beater additive in paper manufacture.

Further information on the product may be obtained by writing Shawinigan Resins Corp., Department AS, Springfield, Mass.

W. Ronald Benson, Inc. of Seattle has been appointed as the company's sales agent in Washington and Oregon. The appointment becomes effective immediately.

The Benson organization will handle the sales of Shawinigan's entire product line of polyvinyl resins and emulsions in the Pacific Northwest.

Benson, with headquarters in Seattle, also maintains offices in Portland and is well known throughout the Northwest as an agent for industrial chemicals and raw materials.

Cyanamid

Charles R. Witschonke has been appointed manager of paper chemicals research for American Cyanamid Co.'s Industrial Chemicals Div.

He is a graduate of Kalamazoo College and received his doctorate in physical chemistry from Brown University in 1941.

In his new position, Dr. Witschonke will direct research on a wide range of synthetic resings, wax emulsions, sizing agents, and specialty chemicals used in the production of paper.

Dow

Facilities for the production of polypropylene are to be built at Torrance, Calif., on a site adjacent to other Dow plastics production units.

The facilities—first of their type for the Western United States—will cost several million dollars to construct.

Reeves

A new 96-page catalog, designated M-592, explains the complete line of Reeves mechanical variable-speed Motodrives.

Copies are available free by writing on company letterhead to Reeves Pulley Div., Reliance Electric and Engineering Co., Columbus, Ind.

Antara

Publication of a 48-page technical manual on ethylene oxide is announced by Antara Chemicals, a Sales Div. of General Aniline & Film Corp.

This manual brings up to date the available information on physical and chemical properties, specifications, analytical procedures, and industrial uses. Extensive data are included on ethylene oxide handling techniques and toxicity, with a detailed and thorough 20-page section on storage, explosion-and-fire prevention and control, protection of personnel and first-aid instructions, protective equipment, and tank-car unloading procedures.

Copies of the manual are available upon letterhead request to: Antara Chemicals, a Sales Div. of General Aniline & Film Corp., 435 Hudson St., New York 14, N. Y.

Jefferson

The appointment of Peter S. Vail to the sales staff of Jefferson Chemical Co., Inc., Houston, Tex., was announced recently by R. E. Werley, Jr., the firm's sales manager. The appointment is effective immediately and Mr. Vail will be assigned to the company's regional sales office in Chicago.

W. R. Grace

The Board of Directors has approved in principle the acquisition on behalf of Dewey and Almy Chemical Div., of the assets of Endura Corp. of Quakertown, Pa., and the stock of The Vellumoid Co. of Worcester, Mass. The acquisition is subject to final audit and court license. Terms were not disclosed.

Endura manufactures pressure-sensitive tape backings and latex-impregnated tape backings, shoe stay material, coating base for specialty clay-coated printing papers, artificial leather coating bases, and impregnated papers for high-pressure laminates. Vellumoid is the world's leading manufacturer of nonmetallic gaskets, which include impregnated fiber gaskets and packing and latex impregnated materials.

Dewey and Almy plans to use the acquisitions as part of its Polyfibron (polymers-fibers) Div. headed by Russell L. Haden, Jr., general manager.

The stock of both companies is owned by the Phillip C. Beals Trust, established by the late George C. Beals, founder of Vellumoid and former owner of Endura. President of Endura is Phillip A. Lamb. President of Vellumoid is Phillip C. Beals.

Bauer

Phillip D. Case has been appointed sales representative of Bauer Bros. Co. in the New York State area.

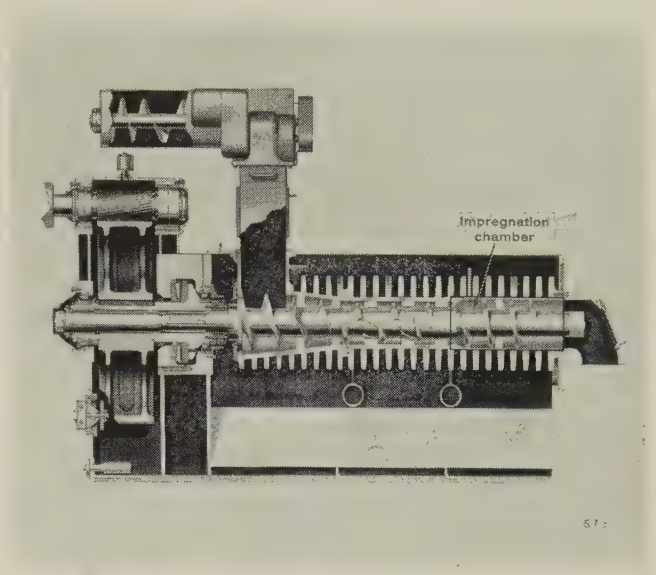
A new machine developed by Bauer Bros. greatly reduces the time needed for impregnating wood chips and other cellulosic materials. The Bauer No. 567 Impressafiner, a special modification of the Pressafiner, provides continuous pressurized impregnation with high uniformity.

Where an hour or more was formerly required for the cooking or soaking of wood chips in certain processes, impregnation can now be accomplished in a matter of seconds.

In addition to impregnating wood chips with cooking liquors, the new unit can also be used for the precise addition of bleaches and other chemicals, and for the restoration of moisture to sawdust, overly dried chips, hogged scrap lumber, and similiar materials.

To obtain maximum accuracy and speed in solving complex engineering and research problems, engineers of the Bauer Bros. Co. are now using an IBM 610 electronic computer recently installed in the company's main office in Springfield, Ohio.

According to James Irvine, Assistant Director of Engineering for Bauer, the computer will save many weeks, and sometimes months, in the design of new machines; it now handles stress and deflection analyses, performs analytical research work, and estimates prices for certain newly designed machinery.



Bauer Impressafiner

General Electric

A completely redesigned medium voltage a.c. motor starter of special significance to pulp and paper industries has been announced by the General Electric Co.

Called Limitamp Control, the re-designed controller features a new draw-out contactor and fuse-shelf assembly. It is designed to provide short-circuit protection and coordinated control for squirrel-cage, synchronous, and wound-rotor motors up to 3000 hp. rated from 2300 to 4600 v.

Applications in the pulp and paper industries include medium-voltage motors driving production equipment such as Jordans and refiners, beaters, pulpers, and chippers. Limitamp controllers are also used on auxiliary motors driving pumps, compressors, small grinders and fans, as well as on motor-generator sets.

According to engineers at the Company's Industry Control Dept., Roanoke, Va., the starter is designed to effectively withstand high humidity and corrosive atmosphere.

Incorporating a unique draw-out, stab-in contactor and fuse assembly for quick, positive connections, the new Limitamp starter can be installed in half the time necessary for previous models. Routine and major maintenance has been greatly simplified according to General Electric engineers. In developing the completely coordinated design, engineers placed special emphasis on the safety of both the equipment and the personnel.

Rolling out the new combination high-voltage contactor and fuse-shelf assembly at the bottom of the control enclosure is an easy one man job. With the high-voltage contactor assembly out, a swing-out low-voltage panel at the top of the control enclosure allows access to the removable barriers. These barriers partition off the incoming cable and bus compartments. With barriers removed, plenty of space is provided to install both incoming-motor and power cable. No sharp cable bends are required and space is available for preparing stress cones on both motor and incoming line cables.

As the contactor-fuse assembly is rolled back into position, stab-on self-aligning contacts automatically plug into the de-energized power circuit. Control power is also automatically engaged. With a grounding strap and door lintel in position, the new Limitamp control is ready to operate.

Absence of floor sills is another new feature. This helps simplify installation by eliminating grouting and associated installation expense.

General Electric's new Limitamp controller is all-front connected to simplify maintenance and all maintenance can be performed with the draw-out contactor and fuse assembly in place. Contact tips can be replaced in less than 15-min. using the magnet head wrench provided. Captive hardware is standardized and interchangeable where possible. Coil changes and fuse replacement can be accomplished in a matter of minutes.

A built-in test circuit permits the controller to be operated and checked while isolated from the normal power supply. All high-voltage components are automatically disconnected and isolated from incoming line and bus before the enclosure can be entered. All high-voltage compartments are isolated by metal barriers.

An interlocking scheme prevents mistreatment of the new controller. The operating handle which energizes the high-voltage contactor cannot be turned to the "open" position while the motor is on the line. When the a.c. contactor is opened, the interlocking mechanism permits the operating handle to be turned to the "open" position and the high-voltage contactor is safely isolated.

Another feature—a "door forgetter"—always keeps the high voltage compartment door closed when the Limitamp starter is energized. Safety shutters between high-voltage fuses and incoming power bus isolate high voltage from exposed portions of the controller. The safety shutter automatically drops into position and isolates high-voltage power when the operating handle is turned to the "open" position.

General Electric engineers stressed that the latest developments in materials, components, and manufacturing processes were used wherever possible in the new Linitamp control to help minimize down time and provide long equipment life. Corrosion resistant zinc chromate hardware is used, and a special type cable resists moisture, corona, and other damaging forces.

The enclosures' corrosion resistant sheet metal finish is designed to reduce repainting cycles. Phosphate coated metal is treated to provide a permanent bond between enamel and steel. Enamel is then applied in a unique "flow coating" operation.

Bulletin GEZ-2898 describes the complete line of electric indicators and controllers for low cost measurement and control. Included in the description are: d.c. millivoltmeter and bridge-type controllers, temperature scanner systems, and saturable reactor control systems for indication and control of temperature and other variables. Typical measurement applications, principles of operation, control forms, specifications and scale ranges available are also discussed.

Literature on a new gyro-integrating mass flowmeter is available. Bulletin GEA-6925 describes theory, operation, and advantages of industrial flowmeter that measures flow of fuels, industrial liquids, and gases directly in pounds. Includes ranges, specifications and dimensions, and cutaway drawings illustrating principles of operation.

Industrial Nucleonics

The culmination of a nine-year success story unfolded this month when Industrial Nucleonics Corp. moved into new ultramodern research, engineering, and manufacturing facilities, just outside of Columbus, Ohio.

The new 75,000 sq. ft., completely air conditioned Industrial Nucleonics plant comprises approximately one-fifth of a projected future research and manufacturing center. The potential growth of the company and availability of space for expansion were taken into consideration in planning the first unit. The company owns 26 acres of land at the site. Completion of the final segment will provide engineering and manufacturing space for 1600 employees. The present structure has been designed to accommodate 600 employees.

The initial brick veneer structure consists of two completely fireproof units with a bridge joining a three-story administration building with a one-floor manufacturing plant. The administration and engineering headquarters utilizes a ribbon window design for maximum vision while keeping glass exposure to a minimum for economy of heating and air conditioning. Private offices constructed around the perimeter of the administration building have been designed to allow for expansion or flexibility in making changes at a later date. This headquarters building also contains an employee cafeteria, elevator, private conference rooms, and a combination lobby-display area.

Industrial Nucleonics Corp., Columbus, Ohio—New manufacturing, engineering and administration buildings

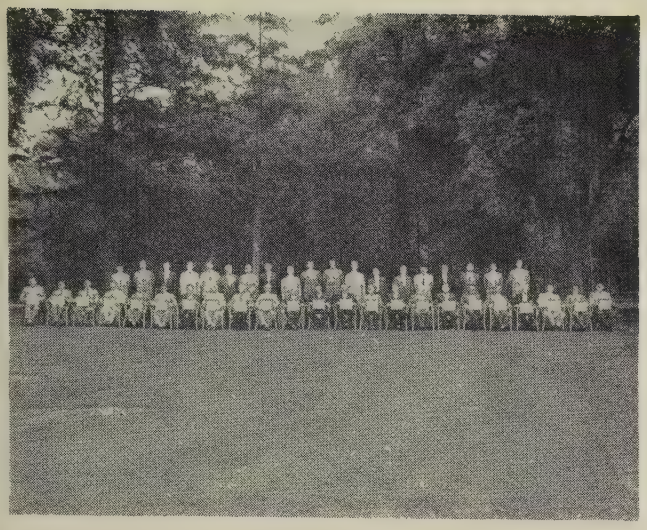
Founded in 1950, by W. E. Chope, president, H. R. Chope and G. B. Foster, vice-presidents, Industrial Nucleonics has grown to leadership in the field of nucleonic-electronic measurement and control systems. The company's AccuRay Process control systems are being used across a wide segment of American industry to perform such tasks as continuously measuring and controlling the thickness of steel, the basis-weight of paper, thicknesses of various plastic films, controlling the uniformity of tobacco weights in cigarettes, continuous measurement of density of fluids flowing in pipes, measurements of level in tanks and bins, and measuring and controlling the level of contents in cans moving on high-speed conveyors.

Coincident with the move into the new facilities was the announcement of the following promotions within the sales organization of Industrial Nucleonics: David A. Bossen general sales manager; and Williard C. Hays field sales manager. Regional sales managers: J. E. Reider, North Central Region and Canada; Larry J. Phelan, New York City; John Yaklevich, Philadelphia; E. J. Amberg, Chicago and Great Lakes Region; Merrill J. Luthman, West Coast; Neil A. Huffman, Birmingham and South Central; George E. Simpson, Houston and Southwest.

Huyck Felt

Huyck Felt Co. recently conducted its 14th Felt Workshop at Rensselaer, N. Y., with 23 papermakers, representing mills from all over the United States, participating. As in previous sessions, discussions covered felt design, the use of synthetics, felt cleaning, chemical treatments, and other subjects of current interest. Also widely discussed were the effects of papermaking chemicals on felts and the new instruments employed by Huyck to measure on-machine felt performance.

A Huyck Felt Co. spokesman stated that the remaining 1959 Felt Workshops have been filled to capacity; an extra session is scheduled for October.



Papermakers attending the 14th Felt Workshop, shown seated left to right, are: George McClellan, Scott Paper Co., Chester, Pa.; Joseph E. Cabot, Great Northern Paper Co., East Millinocket, Me.; Frank E. Randall, Spaulding Fibre Co., No. Rochester, N. H.; Melvin Wilkins, Spaulding Fibre Co., Milton, N. H.; George A. Miller, Brownville Board Co., Brownville, N. Y.; Richard L. Knapton, Hoague-Sprague Corp., Davis Boxboard Div., West Hopkinton, N. H.; Harold Shannon, MacAndrews and Forbes, Camden, N. J.; John L. Revil, George O. Jenkins, Co., Bridgewater, Mass.; Charles E. Stewart, St. Regis Paper Co., Bucksport, Me; John Crowe, Superfine Paper Mills, New Hartford, N. Y.; Henry Peters, Hopper Paper Co., Taylorville, Ill.; Donald Lamm, Hopper Paper Co., Reading, Pa.; Thomas Keville, Continental Can Co.; Richard Anderson, Kimberly-Clark Corp., Fullerton, Calif.; John Clucky, Superfine Paper Mills, New Hartford, N. Y.; Robert Densmore, Claremont Paper Mill, Claremont, N. H.; Eldric A. Eno, International Paper Co., Corinth, N. Y.; Henry F. Parrish, Sealright-Oswego Falls Corp., Fulton, N. Y.; William Trackey, Marinette Paper Co., Ft. Edward, N. Y.; William H. Marlowe, Sealright Oswego Falls Corp., Fulton, N. Y.; James G. Dunlap, Rhinelander Paper Co., Rhinelander, Wis.; Charles Angersback, Personal Products Corp., Milltown, N. J.; Pat Bishop, Gardiner Paper Mills, Gardiner, Me.

Members of Huyck Felt Co. staff, standing left to right, are: William S. Hodges, John D. Skeer, John P. LaRue, Richard H. Meyer, Donald R. Christie, Roderick T. Clarke, Dan M. Wicker, Wilhelm Moe, Norman C. Gould, Otto Berggren, William C. McClure, John H. Hintermaier, Arthur S. Hayeslip, Earl D. Rhodes, Irving H. Peters, Raymond G. Keim, Thomas M. Alexander, Clifford A. Farley, Hans H. Dirzuweit

OBITUARIES

John William Church

John W. Church, Eastern Manufacturing Manager of Building Products, Ltd., Montreal, Canada, died on June 2, 1959, in Montreal.

Mr. Church was born in New Glasgow, Nova Scotia, on March 27, 1905, and graduated from Dalhousie University (1926) and the Massachusetts Institute of Technology in 1929.

He joined Building Products Ltd. in 1937 as a research worker. In 1942 he was appointed assistant superintendent at Point Rouge and a year later he was promoted to plant manager. In 1946 he was appointed Eastern Manufacturing Manager with responsibility for four plants.

Mr. Church is survived by his wife Jean and two children, Susan and David. He became a member of the Technical Association of the Pulp and Paper Industry in 1957.

Carl August Sholderbrand

Carl A. Sholderbrand died in Dundee, Ore., on Aug. 16, 1959.

Mr. Sholderbrand, Plant Superintendent, Spaulding Pulp & Paper Co., Newberg, Ore., was born in Lungsund, Sweden, on Dec. 2, 1892, and graduated from the Technische Hochshule in Darmstadt, Germany, in 1917.

He entered the pulp and paper industry as a chemist for Bervik-Ala Co. in Sweden and was subsequently employed by York Haven Paper Co., Riordon Co., Spruce Falls Pulp & Paper Co., E. B. Eddy Paper Co., G. D. Jenssen Co., Chemipulp Process, Inc., Hawley Pulp & Paper Co. and Spaulding Pulp and Paper Co. as a chemist and sulphite superintendent.

Mr. Sholderbrand joined the Technical Association of the Pulp and Paper Industry in 1924.

He is survived by his widow in Dundee, Ore.

Lee F. Hawley

Lee G. Hawley, one of the founding pioneers of the U. S. Forest Products Laboratory, Madison, Wis., half a century ago and a noted research chemist, died Aug. 19, 1959, at a Madison hospital. He was 77 years old.

Dr. Hawley came to Madison in 1909 as a chemist to help organize the federal laboratory set up here by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Wisconsin. He had joined the Forest Service as a chemist in 1907.

When he arrived with the first contingent of scientists who had been doing cooperative work at other universities, the new building being constructed for the laboratory by the University was not yet finished. A house in the University Heights district was used as temporary headquarters.

Except for 2 years with Arthur D. Little, Inc., a private research organization, Dr. Hawley remained at the laboratory until his retirement in 1942 because of eye troubles. Since then he had lived at 1 Langdon St. For a period in 1944 he was a consultant to the Federal Office of Scientific Research and Development.

In 1916, Dr. Hawley became chief of the laboratory's section of derived products, now the division of wood chemistry. For a decade he directed this research, laying the groundwork for much subsequent progress in utilization of wood by chemical means. He advanced to the post of coordinator of research in 1926, succeeding the late Dr. Aldo Leopold as assistant to Director Carlile P. Winslow.

Dr. Hawley's early research at the laboratory dealt with wood distillation. One outgrowth of that work was a highly pure form of charcoal that came into use during World War I for gas masks worn by American and other Allied troops in poison gas warfare. During both World Wars he was a consultant to the Chemical Warfare Service.

Author of many Laboratory research publications, Dr. Hawley was a co-author with Louis E. Wise of "The Chemistry of Wood" one of a series of American Chemical Society publications. When this book was subsequently expanded and revised, he remained author of the chapter on wood combustion. He also authored a textbook on "Wood Distillation."

Dr. Hawley was a charter member of the American Chemical Society's division of cellulose chemistry, serving at one time as its secretary. In 1952, the society honored him for his 50 years of "loyal support and faithful service." He was also a member of the Society of American Foresters and of Alpha Chi Sigma and Sigma Xi fraternities.

A bachelor all his life, Dr. Hawley was a native of Steamburg, N. Y., where he was born Feb. 12, 1882. He received his academic degrees in chemistry at Cornell University, Ithaca, N. Y., where he taught chemistry from 1903 to 1907.

Interment was at the family burial plot in West Randolph, N. Y.

ENGINEERING DIVISION

Committee Contributions

Questions and Answers

(*23*) *Question:* How can a density or specific gravity measurement be made without the use of a reference chamber?

(*23.1*) *Answer:* One method utilized the standard differential pressure measurement, with a water purge being used in place of an air purge, thus eliminating suppression. The suppression is ordinarily obtained by the use of a reference chamber.

(*24*) *Question:* Is there some means available for measuring moisture in a pulp mat traveling on a nonconductive conveyor?

(*24.1*) *Answer:* Two detector rolls may be mounted, one in front of the other, approximately two inches apart, with one roll grounded. With this equipment the surface resistance of the pulp mat may be measured, which is indicative of the moisture content throughout the mat.

(*27*) *Question:* Can the consistency of the stock in an agitated chest be measured successfully by measuring the agitator power?

(*27.1*) *Answer:* Many such applications have been made over a period of many years with the results ranging from excellent to complete failure.

In general, propeller type agitators designed to do a good job of circulating the stock are not very sensitive to variations of consistency. However, low speed, large blade propellers may provide the indication desired as long as the submergence is comparatively uniform. This type agitator produces the best results in consistencies of 4% and higher.

Agitators designed to produce mixing rather than circulation such as the rotating baffle or gate type agitator usually offer excellent results on consistency measurements down to 2%. Complete or at least uniform submergence is also required for the success of type measurement as this.

(*28*) *Question:* Geological sections in this area are such that the mill area benchmarks are unreliable. The section is cavernous with overhanging ledges. In general, it is made up of yellow clay silt, sand, gravel, residual clay, and chert.

Present benchmarks are set on friction piles which are unstable in this type of material and change from month to month and year to year, giving unreliable data.

What type of benchmarks could be used successfully in this condition?

(*28.1*) *Answer:* Benchmarks have been installed at another mill with similar conditions which would probably suit the conditions mentioned in the above question. They have been very stable and not affected by the geological sections.

A 3 1/2-in. standard weight pipe casing was installed to rock. Inside of this casing was installed a 2 1/2-in. standard weight steel pipe, using 2 1/2-in. steel screwed coupling connections. The 2 1/2-in. pipe extended into a 3-in. diam. hole in the rock to a minimum distance of 10 ft., of which the last 5 ft. was in solid rock. A seal of rope or oakum packing was used to seal between the 3 1/2-in. diam. casing and the 2 1/2-in. diam. pipe at the rock and was backed up against the first, 2 1/2-in. screwed coupling in order to place it properly. The space between both of these casings was filled with grease.

Inside of the 2 1/2-in. pipe, a 1-in. standard weight pipe was installed to a depth of the 2 1/2-in. pipe. Both of these pipes end about 6 in. from the bottom of the 3-in. hole drilled into rock. Grout was then poured into the 1-in. pipe, filled the hole in the rock and, in turn, filled the area between the 1-in. pipe and the 2 1/2-in. pipe. A stainless steel cap was installed on the 1-in. pipe.

A refinement on this was to install, at the top of the 3 1/2-in. casing, an 8 by 3 1/2-in. standard weight steel pipe and an 8-in. screwed steel coupling with the top of the coupling flush with the grade. The 1-in. pipe cap was then installed about 5 in. below grade and an 8-in. pipe cap was used as a protective cover.

This benchmark was found to be both stable and dependable.

(*29*) *Question:* Has anyone in the pulp and paper industry compared the cost of excessive vacuum power with the cost of steam required for the same drying of a sheet? I use the statement "excessive vacuum power" because everyone must realize that some vacuum is required on every sheet. There are some in the industry who believe that vacuum should be put on the machine to the maximum extent since it assists in the ultimate drying of the sheet, but I have wondered if anyone has actually compared the cost of this type of drying with steam drying costs.

(*30*) *Question:* Where is the economic split between general purpose motors of totally enclosed fan-cooled construction and motors of splashproof construction?

(*30.1*) *Answer:* It is a general practice in applying nontotally enclosed motors in pulp and paper mills to space heat within the enclosure upon de-energization of the motor windings in order to prevent condensation and resultant deterioration of the motor winding insulation.

This space heating can be accomplished by either of two methods: (1) 220-volt enclosure space heaters or (2) low voltage heating of the windings.

The second method is considered preferable as space heating is accomplished within the winding rather than adjacent to the winding. This method is more economical than method 1 for 440-v. motors through 100 hp. and only slightly more expensive for motors 125 to 200 hp. Therefore, using method 2 we can set up the following cost comparison of TEFC versus space heated SP 440-v. general purpose motors 25–200 hp. We can see from cost curves plotted that the economic split point is at 75 hp.

(*31*) *Question:* In jacking a column, it is not usually practical to remove the load a column is supporting or to weigh the load. Therefore, how is it possible to determine the total load a column is supporting?

(*31.1*) *Answer:* By mounting strain gages above and below the jacking structure on the column, the total load can be measured very accurately. As a column is jacked the bottom gage will show a decrease in load. The load on the column will be the difference between the initial reading of the bottom gage and the lowest reading of the bottom gage in microinches per inch times the applicable constant for the particular members. If load is added to the column the total load will be the arithmetic sum of the bottom gages and the top gages in microinches per inch times the applicable constant.

(*32*) *Question:* At very slow speeds on a paper machine requiring heads of approximately 2 in., formation is extremely poor due to bubbles. How is this overcome?

(*32.1*) *Answer:* Seal the headbox, connect it to the most suitable vacuum pump through a control valve, and control the level in the headbox to a higher value. This can be accomplished without increasing the total head by connecting a differential pressure transmitter to the bottom and top of the headbox, through a suitable controller/recorder to the valve, and allows changing the level to the optimum value for the particular machine. A bleed valve into the headbox will probably be required to keep the control valve within range.

(*33*) *Question:* What is a good method of remote indication and/or record of the level of chips in a bin?

(*33.1*) *Answer:* A capacity-type probe unit. However, instead of using the solid type of probe, a piece of flexible cable with a Teflon cover will permit it to be jostled and moved by the chips without damage, while still giving good level indication.

(*34*) *Question:* In measuring level, what is the best way to keep crystals from building up on the end of a bubble pipe with subsequent plugging?

(*34.1*) *Answer:* If an exhalation valve, "duckbill," from a gas mask is installed on the end of a bubble pipe when used in a solution which readily forms crystals, a twofold purpose is served. The escaping bubbles bend the rubber which cracks off any forming crystals. Also, it acts as a check valve, preventing any liquid from backing up into the pipe.

(*35*) *Question:* In measuring the level of molten sulphur when the bubble pipe plugs, the measuring bellows is ruined. The instrument has a range of 0 to 10 in. of water pressure. How can the instrument be protected?

(*35.1*) *Answer:* Automatic reset response should be specified only when really needed for a particular application. Where sustained load changes in the process cause too much offset from control point, it should be considered. Reset response is a disadvantage in a simple control application, sometimes causing excessive overshoot on startups and load changes as well as extremely unstable operation when used with a slightly sticky valve. Besides these disadvantages, the extra cost is from ten to sixty dollars in addition to the cost of a positioner which should be installed on a control valve when used with an auto-reset controller.

Progress in Alkaline Pulping—1955

J. R. BYRNE and D. J. MacLAURIN

This report continues the series (*148—156*) on the technical and topical literature reporting progress in alkaline pulping. It reviews the literature abstracted in the *Abstract Bulletin* of The Institute of Paper Chemistry during the calendar year 1955.

EXPANSION, MODERNIZATION, NEW MILLS

United States

Paper Industry (*1*) reports on some of the more important expansion projects undertaken by United States pulp and paper producers and converters during 1955 and those projects which are indicative of new productive trends. Vaughan (*2*) gives a brief description of the pulp and paper mills in Texas, their products, and the industry in the state in general. The first kraft paper from southern pine was produced in Texas. Otis, and other (*3–6*) give descriptions of the recently opened kraft mill of Rome Kraft Co. which is located 10 miles west of Rome, Ga. Production is 650 tons of containerboard/day from longleaf, shortleaf, Virginia, and loblolly pines. *Tappi* (*7*) reports on a number of important new instrument applications being used at Rayonier's new Jesup, Gal. sulphate mill. *Paper Industry* (*8*) and *Tappi* (*9*) give brief descriptions of the new dissolving pulp mill of Buckeye Cellulose Corp. at Foley, Fla. The second reference gives particular attention to the unique water-treatment plant which supplies softened and demineralized water for part of the year and just demineralized water for the remainder of the time. *Fibre Containers* (*10*) reports on the acquisition by Robert Gair Co., Inc., of Southern Advance Bag & Paper Co., Inc., and Great Southern Box Co., Inc. This brings the net value of the company to $119 million and the total of mills and plants to 38 in the United States and Canada. Rouman and Vanderhei (*11*) discuss the engineering problems encountered in the expansion and modernization of The D. M. Bare Paper Co., Roaring Spring, Pa. A new 128-in. paper machine replaced the old 76-in. machine and, since the existing structure would not house the new machine, a new paper mill building had to be built around the existing building, which was later demolished. *Paper Trade J.* (*12*) discusses the changes and additions made during the last six or seven years at Oxford Paper Co., Rumford, Me. Some of the major additions were a hardwood kraft pulp mill, bleaching plant, and screening system, and a kraft recovery boiler. The main emphasis of an article in *Pulp and Paper* (*13*), which describes the recent moves of the St. Regis Paper Co., is on the pulp mill expansion and improvements at the Tacoma, Wash., mill. The principal components of the Tacoma mill's expansion program were modernization of the wood and chip-handling operations, increase in digester and washing capacity, and the addition of a new recovery unit and precipitator. *Pulp and Paper* (*14*) also reports on important phases in the modernization-expansion program at St. Helens Pulp & Paper Co., St. Helens, Ore. The total capacity of the mill is now 335 tons per day.

J. R. Byrne, Research Assistant, and D. J. MacLaurin, Chief, Pulping and Papermaking Section, The Institute of Paper Chemistry, Appleton, Wis.

Canada

Recent plant improvements at the Dryden Paper Co. Ltd., Dryden, Ont., are described (*15*) which have resulted in a daily pulp production of 260 tons. When the mill is completed in 1957 (*16*), the additional 72,000 tons of bleached kraft pulp to be produced will amost double the present production. *Canadian Pulp and Paper Industry* (*17*) describes recent improvements at the Ocean Falls, B. C., mill of Crown Zellerbach Canada, Ltd. Among them is the rebuilding of the no. 3 kraft paper machine to accommodate a size press, making possible runs of 100% fir. *Pulp and Paper* (*18*) reports on the planned expansion of MacMillan and Bloedel at Port Alberni, B. C., which includes a newsprint mill, board mill, and expanded pulp capacity at a cost of $35 million. The pulp mill will increase production to about 400 tons daily, and newsprint output will be 100,000 tons annually.

Norway

One of the oldest chemical pulp and paper mills in Norway celebrated its 70th anniversary in 1954 (*19*). The sulphate mill was built in 1884, followed by a paper mill in 1891. A brief outline of the history of the mill and a description of the extensive modernization of recent years is given. The mill originally used spruce and pine logs, but in recent years started to utilize the waste from sawmills.

Pakistan

World's Paper Trade Rev. (*20*) reports that the Karnaphuli Paper Mills Ltd. in East Pakistan are now producing paper at the rate of 70 tons per day. New machinery has been installed so that a total of 30,000 tons of bamboo pulp can be produced each year, and from this it is estimated that the paper mill will annually produce 25,000 tons of paper.

India

Schnyder and Harwick (*21*) describe a new mill in Central India. The facilities include a groundwood mill, kraft mill, bleach plant, paper mill, black liquor recovery system, and the development of a townsite for the 650 mill and 1250 forest operators. Trial operations of the groundwood and paper mills began in January, 1955. The kraft mill was expected to start up several months later. The fibrous raw materials used at the mill are salai and bamboo.

THE COOKING PROCESS

Every (*22*) presents an elementary discussion of the kraft pulp and paper industry, including a definition, differences from other pulping processes, advantages of kraft pulp, bleaching, kraft paper and paperboard, the present accelerated expansion, and uses of kraft. *Paper-Maker* (London) (*23*) describes the sulphate

cooking process as commonly found in Europe. The differences between kraft and sulphite pulps are also discussed. Goodwin (*24*) discusses the application of Pandia continuous digesters to the pulping of various materials by different processes. Huestis (*25*) describes the different stages in the manufacture of kraft linerboard, including an outline of the control tests made at each stage of the operation.

The part played by instrumentation at the Calhoun, Tenn., mills of Bowaters Southern Paper Corp. is discussed by Powell (*26*) and the instruments in each department are described. Keyes (*27*) gives a brief description of the development of instrumentation for sulphate digesters of the North Carolina Pulp Co.

Kulkarni and Nolan (*28*) studied sulphate pulping using slash pine chips. The effects of temperature, alkali concentration, and time on wood solution and delignification were investigated, and an equation derived. The equation was applied to the data of other investigators and found to give results which differ by a constant amount for the data of each investigator. Evidence is also presented which indicates that the pulping reaction is accomplished by the movement of a reaction interface which travels toward the chip center. Pre-evacuation before cooking does not increase the depth to which the interface moves. Westcott and Field (*29*) obtained a Canadian patent for an alkaline process in which a group of digesters are connected in parallel. This corresponds to a United States patent awarded them in 1954. Sutherland (*30*) obtained a patent for a high-yield kraft pulping process which includes heating the digester charge to 340° F. at 110 p.s.i. for about 55 min. The resulting pulp and its black liquor are blown into the blow tank and diluted with hot brown liquor (160–180°) from the washers. At 3.25% consistency, the pulp is passed to the refiners eliminating the use of knotters. Foaming is also eliminated because of the high temperatures in the refiners. Dzhelyuk (*31*) presents a discussion refuting the conclusions of an earlier paper of Simkin as erroneous. Simkin's paper concerned a speeded-up sulphate cooking process. Kosaya (*32*) used pine chips and studied the prehydrolysis of sulphate pulp. Richter (*33*) calls for a better understanding of the significance of the component of pulp called alpha-cellulose. He then reviews the methods which can be employed to prepare high alpha-cellulose wood pulp. Attention is directed to the moderate influence of pulping conditions used to produce both sulphite and kraft pulps.

Sivola (*34*) received a patent for a three-phase acid-alkali cooking operation which is capable of producing pulp which is as white as ordinary calcium-base sulphite pulp, has a low pitch content, and is easily bleached. In the first phase the chips are cooked in acid bisulphite liquor to produce incompletely digested pulp. In the second phase the cooking liquor is converted to alkali liquor, and in the third phase the digestion of the pulp is completed in the alkali liquor. Janson (*35*), in a Canadian patent, recommends the sodium salt of hydroxymethanesulphinic acid as a pulping agent in connection with the soda process. Various sulphoxylates of carbonyl compounds are claimed to have greater thermal stability than dithionites.

Mannbro (*36*) continues with the description of the Silfate process. According to the process, the smelt from the recovery furnaces in a sulphate mill is dissolved in spent sulphite liquor; the solution is causticized and used for sulphate pulping. The spent sulphite liquor is evaporated and burned as black liquor without additional expense. Except for certain reservations in the United States and Canada, the Silfate process can now be employed without patent restrictions.

Bhat and co-workers (*37–41*) have continued this series of papers on indigenous cellulosic raw materials of India suitable for the production of pulp, paper, and board. Five of these papers, in which the soda or sulphate process was discussed, were published in 1955. Experiments on soda pulping of elephant grass are described (*37*). Easy bleaching pulps with satisfactory strength properties could be prepared under suitable cooking conditions. The results indicate that the pulp is a good raw material for the manufacture of white writing and printing papers when mixed with a long-fibered pulp. *Trema orientalis* Blume (*38*), when cooked by the sulphate or soda process, gives a yield of about 68%. The pulp's color is brown and the strength properties satisfactory. Mixed with a long-fibered pulp it would give a suitable wrapping paper. *Saccharum procerum* Roxb. was pulped by the sulphate process (*39*). Easy bleaching pulps in considerably higher yields than from bamboo or sabai grass were obtained. Writing and printing papers made from the pulp were characterized by good formation and satisfactory strength properties. Sulphate and soda pulps were obtained from wattlewood (*40*) and the yields were in the range of 65 to 71%. Being a short-fibered pulp, it was mixed with a sulphate bamboo pulp and made into a suitable grade of wrapping paper. Laboratory experiments were also carried out on *Sterculia alata* Roxb. (*41*), a tall evergreen tree. The yields of bleached sulphate pulps were not high, the bleach requirements were considerable, and the whiteness was not satisfactory. The study showed that the wood was not suitable for the economical production of writing and printing papers.

Aung (*42*) studied the kraft pulping of eight different North American hardwoods. All eight species can be pulped easily by the kraft process, the yield varying with the species. All pulps were easily bleached. The study indicated that the use of species mixtures should present fewer problems in bleaching than in cooking. MacLaurin and Peckham (*43*) made bleachable kraft pulps from 11 different southern United States hardwoods. The pulps were bleached to 80 to 82% G.E. with a modified three-stage CEH sequence, in which the second half of the chlorination stage was adjusted to pH 8 to 9 with caustic. The pulps could not be bleached by a standard CEH sequence.

Jayme and Licht (*44*) describe the conductometric titrations which permitted the determination of sodium hydroxide consumption during the course of a soda digestion of beechwood, in which an unexplained decrease in sodium carbonate was also observed. A modification of the decomposition technique of Heath was used in conjunction with the conductometric titration, thus giving very good values for both sodium sulphide and sodium hydroxide consumption. For beechwood the consumptions were 1.74% NaS, and 14.95% NaOH, and the pulp yields, percentage of lignin, and furfural values were similar to those of previous investigators. Krzysik and Gonet (*45*) evaluated the

growth rate, physical and mechanical properties, and pulp yields of five species of poplar. *P. berolinensis* and *P. deltoides* were considered the best suited for making pulp in Poland, both from the technological and economical standpoint. Adamik (*46*) studied *Ailantus glandulosa*, sometimes called Japanese sumac, in regard to its possible use as a pulpwood. Experimental soda, sodium bisulphite, and calcium bisulphite cooks gave yields of 49.3, 54, and 49.2%, respectively. The unbleached pulps have a relatively high brightness, and the strength properties may be considered satisfactory as compared with other hardwood pulps. Koeppen and Sitzman (*47*) investigated the physical, chemical, and pulping properties of klinki pine and hoop pine from New Guinea. The sulphate and sulphite processes gave good yields of pulps, with the sulphate pulps having superior strength properties. Higher tearing strengths were found with these pulps as compared with good quality commercial sulphate pulps. Watson (*48*) also did work with the hoop and klinki pines of New Guinea and, in general, confirmed the results of the previous investigators. Koeppen and Cohen (*49*) made a pulping study of five species of mangrove. A good yield sulphate pulp could be easily obtained from all five species. The over-all strength of pulps of three of the species was similar to that of the corresponding pulps from *Eucalyptus regnans*.

Ijff (*50*) carried out an investigation to ascertain the suitability of Surinam hardwoods, digested as a mixture, for the manufacture of various grades of paper. The study was preceded by a separate examination of the pulping properties of the individual hardwoods, and the unsuitable ones were discarded. Two mixtures were then prepared: one from 45 species found at high elevations, and the other from 15 river-bank and marsh species. A 50% yield was obtained from both mixtures using a modified sulphate cook. Bleaching experiments on these pulps were successful when a multistage process was employed in which either gaseous or an aqueous solution of chlorine was used in the first stage. Bleaching with hypochlorite alone or with chlorite, peroxides, or zinc hydrosulphite appears to be impossible with either pulp.

Zaitseva and Fedorishcheva (*51*) studied the kraft pulping of Daursk larch. Sproull (*52*) gives preliminary data on the alkaline pulping of several varieties of bamboo; kraft and modified Raitt processes were applied. Atchison (*53*) outlines the most important individual processes available for the pulping of bagasse with comments on the highly important depithing operation which should precede any of the processes. Nolan (*54*) studied the alkaline pulping of bagasse for both papers and dissolving pulps. He first describes how the pith was removed. The depithed fibers were then pulped with the intent of preparing a dissolving pulp. Pulps containing 95 to 96 % alpha-cellulose were obtained; however, the D.P. of 1700 to 2000 obtained is much too high for xanthation. After bleaching, the D.P. fell to 880 which is about the correct value for xanthation. Papermaking pulps were made in yields of 60 to 63% and showed remarkably high burst, tensile, and folding strengths, but were low in tear.

Atchison (*55*) gives the development and a description of the Pandia continuous digester process and lists factors in its applicability to pulping straw and bagasse. Dreyfus (*56*) obtained a patent on a process for the manufacture of cellulose from straw in which the chopped material is cooked with 10 times its weight of a 1% NaOH solution for an hour. It is then washed, dried, and boiled for 5 hr. in 90% ethyl alcohol. It is washed and again boiled in sodium hydroxide for 1 hr. The product is then filtered, washed, and bleached with calcium hypochlorite. The product, which is lignin free at this stage, is treated further to remove the greater portion of hemicelluloses which still contaminate the material. Thiriet (*57*) refers briefly to a study made in 1945 in which straw pulps were produced by different alkaline methods. The Thiriena process (caustic soda and carbonate at atmospheric pressure with countercurrent operation) is described in detail. Jones and Scott (*58*) report on a Canadian patent in which cellulose is produced from raw lignocellulosic material by impregnating the material with a 2 to 5% aqueous solution of caustic alkali, lowering the temperature until all the water present is frozen, keeping the temperature constant for 1 to 5 hr., raising the temperature to melt all the ice, removing the greater part of the alkali solution containing dissolved pentosans, and then subjecting the material to a delignifying treatment. Marton, *et al.* (*59*), made kraft, monosulphite, and bisulphite cooks on wheat and rice straw. Kraft cooks were made at maximum temperatures of 100, 140, and 170°C. using 15% cooking chemicals with a sulphidity of 15%. The removal of lignin was a function of temperature, but was practically complete at the end of an hour in each case. However, carbohydrate removal continued with time. Chesley and Gilmont (*60*) made laboratory and mill-scale studies which show that the bursting strength and tear values of pine kraft pulp are not significantly changed when sulphidity in the cooking liquor is decreased from 30 to 20%. However, further lowering of sulphidity produced noticeable changes in pulp strength. Shirriff and Rowley (*61*) report on the determination and measurement of soda losses from the five major sources of loss at the Long Lac Pulp and Paper Co., Ltd. in an attempt to establish a mill sodium balance. The five sources investigated were main sewer, evaporater sewer, washer sewer, stock loss, and pulp loss. Simmonds, *et al.* (*62*), prepared a series of pulps from sweetgum by the prehydrolysis-sulphate pulping process primarily for the purpose of investigating certain properties of nitrated pulps in relation to pulp properties and conditions of preparation. Keller and Borlew (*63*) studied the suitability of a rapid chlorine-number determination as a mill-control method for measuring the degree of delignification of high-yield kraft pulps. The dependence of chlorine number on lignin was found to be linear, the correlation coefficient being 0.998. Lindberg (*64*) studied thiolignins obtained by sulphate digestion of spruce in regard to hydrogen bond formation. Keilen (*65*) describes work of the West Virginia Pulp and Paper Co. in the utilization of lignin. With the wider adoption of the alkaline pulping of southern pine, it was determined that over 8 million tons of lignin become available each year. The approach to finding markets for this lignin is outlined.

WASHING AND SCREENING

Waters and Bergstrom (*66*) discuss how the dilution

curve has aided in the determination of the feed concentration to the evaporator. The lack of a proper method has led in the past to the purchase of evaporation equipment which ultimately proved to be a bottleneck in mill operations. With particular reference to esparto, Mitra (*67*) emphasizes the advantages of vacuum filter countercurrent washing of soda or sulphate pulps over the practice of washing in the digester, followed by washing in potchers. Fiber losses as low as 30 p.p.m. and a much stronger black liquor going to the evaporators are claimed for the installation. Griffith (*68*) reports on the problem the Camas mill of Crown Zellerbach Corp. faced concerning pulp cleanliness and the simple test they found as a control aid. The test also furnishes data which can be correlated with black liquor dilution at the washer and chlorine consumption in the bleach plant.

Ebersole and Simmons (*69*) give a brief description of the pulp-screening system at the Macon Kraft Co., Macon, Ga. The methods used for consistency control and screen loading are also outlined. Cadigan (*70*) reports on the installation of a battery of six Oliver-Ahlfors upflow-unit-type screens for screening kraft pulp after bleaching at the Tacoma, Wash., plant of St. Regis Paper Co. It is the largest installation of the screens in any one plant in the United States. The installation is unique in that it is incorporated into a mechanical refining stage in the bleach-plant operation.

SULPHATE LIQUOR CYCLE

Smith (*71*) discusses some of the recent improvements in the design of recovery units. Although the pattern for present-day recovery unit design originated in 1937, continuous improvements have been made which result in greater economies through higher steam-generating efficiency, decreased maintenance, and higher availability. Edling (*72*) describes Swedish experience with recovery and evaporating units for black and spent sulphite liquor. Joglekar and Nanda (*73*) review the possibilities of waste recovery as they apply to conditions in the Indian pulp and paper industry, with particular reference to the utilization of spent sulphite and black liquors. Chêne, *et al.* (*74*), have devised a method for the determination of caustic soda, sodium carbonate, and sodium sulphide in spent liquors. It involves distillation in the presence of ammonium chloride and gives results sufficiently precise for purposes of analytical mill control. Ayroud, *et al.* (*75*), studied three general methods for showing the presence of phenolic bodies and their halogenated derivatives as described in the *Journal Officiel* of June 20, 1953. None of them showed the high sensitivity toward a solution of phenol ascribed to them in the publication. Extensive individual experiments were made with different solutions and with certain black liquors. When the black liquor was sufficiently concentrated, faint positive tests were obtained with two of the methods. No specific phenols were isolated from the black liquors.

Some of the recent progress in the oxidation of sulphate black liquor is discussed by Collins (*76*). Most of the progress has been in the further application on foaming and nonfoaming liquors and design refinements. The beneficial results at various points of the kraft process from the oxidation system are enumerated. The only disadvantage that can be foreseen is a probable increase in corrosion in the green and white liquor systems resulting from the higher sulphidity. Guillon (*77*) suggests that, since black liquor solids contain approximately 5400 cal. per kg. of 90% dry pulp, the production of power and steam from recovery can almost be sufficient for operation of the mill. Since improvement in the fuel value of the liquor did not result from the use of multiple-effect evaporators, additional processes have been devised; for example, the Bergstrom-Trobeck process of liquor concentration which is described. Laguilharre and Ciboit (*78*) discuss the fundamentals of the Laguilharre processes (which aim essentially at the recovery of heat in flue gases) for a small mill where the flue gases are used directly, a large unbleached pulp mill where the conventional recovery system and Laguilharre system are combined, and for a complete recovery system for a bleached pulp mill. Bories (*79*) discusses the problem of finding a solution for thermic recovery, with emphasis on the fact that mill size is an important factor. Different furnace systems used to burn black liquors are reviewed. Mention is also made of a new process, Torras Xucla, which will soon be employed. Komshilov and Letonmyaki (*80*) studied the precipitation of organic material during kraft liquor evaporation and report that it results from the breakdown of a colloidal system, the principal component of which is alkali lignin. This system is stable at 1.14% active alkali as Na_2O and unstable at 0.7%. Lockman and Jenssen (*81*) have modified the conventional method of circulating condensates from the first to last stages of evaporation to permit more efficient recovery and reuse of the heat in the over-all condensate system.

Basberg (*82*) compare sulphur losses and heating value of the concentrated black liquor for disk and multistage evaporators. It appears that greater sulphur and heat-value losses occur in disk evaporators. Copenhaver, *et al.* (*83*), obtained a patent for a chemical recovery process. After concentrating black liquor obtained from neutral and alkaline pulping processes to approximately a range of 25 to 60% solids, the liquor is acidified to liberate the acetic acid, which is then extracted from the concentrated black liquor with methyl ethyl ketone; the latter may subsequently be separated from the acetic acid by azeotropic distillation. Hagglund and Enkvist obtained a Canadian (*84*) and United States (*85*) patent for a method of producing methyl sulphide in which sulphate black liquor is heated in the presence of a substance containing inorganic sulphidic or hydrosulphidic sulphur at 150 to 500°C. The residual black liquor may be subjected to combustion as in the conventional sulphate process. Brunes, *et al.* (*86*), discuss different ways of installing a wet-combustion plant for the waste liquors of pulp mills. The advantages and disadvantages of the wet-combustion system as applied to standard sulphite and kraft mills are discussed. Kennedy (*87*) gives a brief history of waste-liquor burning and the trend in the design of waste-heat and chemical-recovery units. The source and preparation of the fuel and methods of burning are discussed along with a comparison of typical analyses of waste-liquor solids.

Alava (*88*) discusses the recent general development of recovery furnaces and the novel types used in the Finnish sulphate industry. A description of the Tam-

pella JMW recovery furnace is given along with the heat and material balance of the furnace. Singleton (*89*) obtained a patent for a furnace with two or more discharge nozzles directed downward at such an angle that a combustion zone is maintained just above the hearth. Roberts, *et al.* (*90*), received a patent for a method of removing impurities from recovery furnace gases by means of electrical precipitation of the material in the dry state on charged electrodes and mechanical vibration of the electrodes to cause the particles to fall directly into a body of black liquor below the electrodes. West (*91*) discusses the operation of a 250-ton B & W recovery unit equipped with a black liquor venturi scrubber which was started up in May, 1953, at Thilmany Pulp & Paper Co., Kaukauna, Wis. The unit shows chemical collection efficiencies of approximately 90%, and heat recovery greater than normal. Hochmuth obtained a Canadian patent (*92*) and a United States patent (*93*) for a temperature-actuated method for controlling the liquor composition and level in the ash-dissolving tank of a black-liquor recovery unit. *Pulp and Paper* (*94*) describes a smelt-tank setup in a Tomlinson recovery unit which incorporates a waterfall effect produced by an underlip added to the spout through which water flows to the tank and which assists in breaking up the molten smelt stream. Since the installation, explosions have been rare and minor in extent. Sallack (*95*) reports on laboratory experiments which have been carried out in the attempt to eliminate explosions in smelt dissolving tanks. The experiments showed that violent explosions could be produced with sodium carbonate smelt contaminated with over 5% salt or 10% NaOH.

Miller (*96*) gives a description of the Roberts pressure filter, employing graded Anthrafilt (anthracite coal) as a medium which serves the twofold purpose of clarifying the white liquor and providing a safety factor for any operational upset which might occur in the clarifier. Haegland and Loschbrandt (*97*) studied TAPPI Standard T 624 m-44 for the determination of sulphide, thiosulphate, and sulphite in white liquor. The method invariably results in too high iodine consumption and an error of several hundred per cent may result. The difficulties can be avoided by making the thiosulphate solution weakly acid by the addition of acetic acid and then titrating directly with iodine.

STREAM AND AIR POLLUTION

Wetherhorn (*98*) describes the program of Southern Paperboard Corp.'s mill at Port Wentworth, Ga., for steam pollution abatement by balancing and improving the recovery system. Amberg (*99*) reviews water reuse possibilities and problems in sulphite and kraft mills. The prediction is made that through efficient water usage the water requirements per ton of pulp and paper will continuously decrease over the next 20 years. Phillips, *et al.* (*100*), describe the water treatment facilities at the sulphate mill of Reigel Carolina Corp. at Acme, N. C. Moggio (*101*) points out that the problem of color removal from kraft mill effluents has not kept pace with the progress made in biological stabilization of these effluents, mainly because the color-imparting materials exert little or no biological oxygen demand. However, color removal is important from the standpoint of the effect of color in streams on public opinion. Several methods of removing color are presented.

The subject of a Canadian patent by Zimmerman (*102*) is the oxidation of waste effluents by the introduction of compressed air under pressure of 1500 p.s.i. into a tank containing the waste material heated to the point at which oxidation will take place. Webster (*103*) describes how the selection of the site for the Valdosta, Ga., kraft board mill was affected by stream pollution problems and how the effluent control system was planned before any announcement regarding the new mill site was made. A brief description of the system is also given. Bishop and Wilson (*104*) describe the full mill scale treatment plant employing the aeration process for accelerated reduction in B.O.D. of kraft mill wastes installed at Southland Paper Mills, Lufkin, Tex. *Pulp and Paper* (*105*) gives a description of the mill effluent disposal system of the East Texas Pulp and Paper Co., Evadale, Tex. One million dollars were invested in the system. Miller and Kniskern (*106*) describe the different phases of the pollution abatement activities at West Virginia Pulp and Paper Co., Covington, Va. Eckenfelder and Moore (*107*) discuss the two principal methods of the biochemical oxidation of waterborne organic wastes through the agency of living organisms, trickling filters and the activated-sludge process. An example of an activated-sludge plant is that of West Virginia Pulp and Paper Co. *Chemical Engineering* (*108*) also gives a brief description of the waste treatment plant at Covington. Ayroud, *et al.* (*109*), report that the official method for B.O.D. determinations cannot be applied directly to waters polluted with alkaline spent liquors. The classical Winkler technique proved satisfactory, providing certain precautions were taken. Attempts to determine B.O.D. by using potassium permanganate are valueless. Zielinski (*110*) reviews the composition and properties of waste liquors derived from sulphate pulping. Analytical methods for the determination of the degree of toxicity of rosin acids and sulphides, and the relation between the B.O.D. and the amount of objectionable compounds in an effluent are discussed. Grant (*111*) discusses effluent treatment from the point of view of a British pulp and papermaker. The importance of effluent prevention as distinct from correction is emphasized and a new method (Scholler process) is briefly described for pulping straw and esparto by the soda process without the production of any effluent whatsoever.

Freudenberg and Reichert (*112*), in a letter to the editor of *Tappi* with reference to an article by Ghisoni, state that the odors of sulphate pulp mills have not yet been eliminated. Von Bergen (*113*) discusses the principles of odor counteraction and their application to the treatment of odorous air pollution by industry. Meuly and Tremaine (*114*) obtained a patent for a method for reodorizing malodors found in the relief gases and digester blowdown in the typical sulphate cooking process. The method consists of adding to the digester 1 to 100 p.p.m. of a mixture of at least three odor-bearing organic compounds with different boiling points. Wright (*115*) reports that, although recent developments have led to a great reduction in kraft mill malodors, there is still a small amount of residual odor principally from the stack gases from the recovery plant.

The mathematical theory of smoke dispersion as developed by Sutton is applied to the problem, and the effect of the different variables is shown in a series of curves. Very tall chimneys are not in themselves a solution to the problem, and would only be justified in conjunction with other measures. Wright and Klinck (*116*, *117*) describe the black-liquor oxidation unit at Port Alberni, B. C. It consists of a pair of steel towers, 4 by 4 ft. and 30 ft. high. The interiors are filled with many asbestos-cement plates standing on edge so that the black liquor flows downward over the surfaces. Air mixed with digester relief gases is blown downward between the plates. The relief gases, the principal source of odor in this mill, are absorbed and therefore cannot get out into the air.

The Vaposphere, installed at two mills of the Weyerhaeuser Timber Co., Pulp Division, is described (*118*, *119*). It is a large steel sphere, about 25 ft. diam. Inside the sphere is a rubber-treated diaphragm which swells slowly as it collects the malodorous gases which escape the standard condensing equipment and black-liquor oxidation. The system is judged to be about 90% effective in deodorizing the process. In the first installation, the collected gases are fed into a furnace and consumed. At the second, the gases are siphoned off and destroyed by mixing with chlorine in the bleach plant. A third installation is planned.

BLEACHING

Pearson (*120*) examined the bleaching of kraft pulp from *Pinus radiata* to a blue reflectance of 50 using calcium hypochlorite. A single-stage process at 20°C. and 6.5% stock concentration was found to be economical among single-stage processes in chemical, plant, and heat costs. A two-stage process consisting of a first stage at 3.2% stock concentration at 25°C. and a second stage at 3.2% concentration at 30°C. would be economical in plant and chemical costs. Jensen, *et al.* (*121*), compared the bleachability of birch and pine sulphate pulps. Both pulps were bleached in six stages to a brightness of 84% (Hunter). Results show that the chlorine and alkali consumptions of birch pulps were somewhat lower than those of the pine pulps. The viscosities of the bleached and unbleached birch pulps were higher, indicating a better preservation of strengths.

A description of the bleach plant of the Pensacola, Fla., Kraft Center of St. Regis Paper Co., is given (*122*). Two hundred and fifty tons of pulp per day are bleached in three stages to a brightness of from 80 to 85 points. Seymour (*123*) describes the five-stage bleaching process used by Brunswick Pulp & Paper Co. for bleaching southern pine kraft to 88 to 90% brightness with only 10% loss in strength. Tests for quality evaluation and control of each stage are included. Wiley (*124*) describes the principles of kraft pulp bleaching with particular reference to the six-stage process employed by Riegel Carolina Corp.

Harrison and Calkins (*125*) studied the effect of a number of bleaching variables upon the brightness and strength of chlorine dioxide-bleached southern softwood pine kraft. Bleaching conditions of 155°F., 14% consistency, 0.55% chlorine dioxide, 2 hr. time, and atmospheric pressure, were used as a standard. Rapson (*126*) presents a record of the Pulp Purification Session of the 40th Annual TAPPI Meeting in New York, the subject of which was chlorine dioxide bleaching.

A review of recent practices in the United States and Canada in the bleaching of chemical pulps with hydrogen and sodium peroxide is given (*127*). Noreus and Hella (*128*) report on the substitution of a peroxide stage for the final caustic extraction in a four-stage sequence on jack pine kraft pulp at the Northwest Paper Co., Cloquet, Minn. Pulp brightness was increased from the 78 to 79 range to 81 to 83. The percentage loss in burst and tear during bleaching was slightly less than before. No apparent improvement in brightness stability was found. King (*129*) gives a brief description of the use of Du Pont Solozone sodium peroxide bleach on Douglas-fir kraft pulp at the Weyerhaeuser Timber Co., Longview. McEwen, *et al.* (*130*), report that two distinct methods of application of sodium peroxide to Douglas-fir pulps have been developed at Longview. In one, the peroxide is applied as a final sixth-stage bleach. In the second, the peroxide is used in the second caustic-extraction stage and followed by a final hypochlorite bleach. A comparison of the two methods indicated a definite superiority of the first method. Rowlandson (*131*) reports that the Longlac Pulp and Paper Co., Ltd. has produced an extra high brightness sulphate pulp by replacing the second caustic extraction in a usual six-stage sequence with olozone.

Rollinson (*132*) studied the colored water-soluble materials which are formed during the accelerated aging of bleached kraft pulp. The possible relationship between these colored bodies and the colored material formed during the heat degradation of low molecular weight carbohydrates was investigated. Rollinson (*133*) also studied the effect of certain variables in the bleaching process on the yellowing which occurs when bleached kraft pulps are heated. Extensive washing, thorough caustic extraction, and the maintenance of high pH during the hypochlorite stages were all found to reduce reversion. The presence of added iron was found to increase the extent of brightness reversion, but attempts to increase color stability by the removal of the iron normally present in pulp were unsuccessful.

DIGESTER CORROSION

Pesch (*134*) repeats his plea for developing suitably accurate and practicable methods for the complete chemical analysis of sulphate cooking liquor. The presence of minor liquor components may be responsible for the accelerated rate of sulphate digester corrosion. Ruus and Stockman (*135*) have studied the effect of white liquor on corrosion and have found that corrosion increases with increasing concentration of sulphide, hydroxide, thiosulphate, and polysulphide, but only slight corrosion by the first two in normal concentrations. Lientz, *et al.* (*136*), report on the 5-year investigation carried on by the TAPPI Chemical Engineering Subcommittee. The over-all problem of digester corrosion is considered from the standpoints of economic importance, theoretical background, and practical control. The concept of alkaline digester corrosion now held by the committee is that a safe and economically low rate of metal loss is properly considered a normal condition. Parker (*137*) outlines and discusses several causes of digester corrosion and gives

solutions in some cases. Dela Grange (*138*) describes the type of corrosion in digesters caused by uncontrolled flow of liquor or chips against an inside surface of the vessel. Examples of different types of chemical attack are given, and causes and possible cures are discussed. Hopper and Morrison (*139*) have studied the variables in chemical analyses and physical characteristics of a large group of carbon steel samples taken from kraft digesters, the corrosion effect of variables in white liquor compositions, and the effect on corrosion rates of protective films build-up on the steel by cathodic protection. The results indicated that these are factors which may be contributory to the increasing rate of attack and are worthy of continued investigation.

Pfeiffer, *et al.* (*140*), report on the facts brought forth during the round-table discussion of the TAPPI Corrosion Committee at the 40th annual meeting. The discussion was divided into six subjects all pertaining to digester design and its effect on corrosion in alkaline pulping. Additional data and a re-examination of data previously used are presented by Shoumatoff and Teeple (*141*) in the final part of a survey of alkaline digester corrosion begun in 1953. Among other things, the survey shows that additional fundamental studies of the effect of sulphur chemistry on corrosion are needed. Pfeiffer (*142*) reports that, based on the average corrosion rate of 0.31 i.p.y., alkaline corrosion of digesters is costing pulp mills in the United States 2 million dollars annually.

Stainless steel weld overlay has proved itself to be a suitable method for prolonging the life of kraft digesters subject to localized corrosion. Hopper (*143*) reports that tests made to determine the effect of the overlay on the physical properties of the steel showed no reduction of the properties of the ASTM A-212 Grade A plate. Top and bottom cone areas of three new carbon steel digesters of West Virginia Pulp and Paper Co. were protected by a thin overlay and have given good service since they were placed in operation. Shold (*145*) reports that an investigation of eight lined digesters showed them to be scaled and corrosion free in the cone and shell courses. However, the dome areas were found to be bright and active. The activity is attributed to the corrosive gases given off throughout a kraft cook.

The conclusions arrived at from experiments in the laboratory by Hassler (*146*) indicate that digester corrosion can be minimized by providing suitable operating conditions by which an inert suface established on the digester wall could be kept inert. Polysulphides are one of the most dependable agents for stabilizing a surface. If full advantage can be taken of these and other factors the corrosion will usually be less than 20 mils per year. Haegland and Roald (*147*) studied the mechanism of the reactions which are responsible for the attack on mild steel in white liquor by means of polarization experiments and weight-loss determinations. The principal conclusions drawn are: The corrosion of steel in white liquor is caused by the polysulphides present in the liquor. The sodium hydroxide concentration affects the corrosion process by determining the concentration of nonhydrolyzed sodium sulphide in the liquor. The corrosion rate is dependent upon the rate at which polysulphide ions are carried to the corroding steel surface. High polysulphide concentrations inhibit the corrosive attack by exerting a passivating effect on the steel.

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147. Haegland, Borge, and Roald, Bernt, *Norsk Skogind*, 9, No. 10: 351–362, 364 (Oct., 1955); *B.I.P.C.* 26: 271.
148. Wells, Sidney D., *Paper Trade J.* 125, No. 18: 42–47 (T. S. 206–211) (Oct. 30, 1947); *B.I.P.C.* 18: 145.
149. Wells, Sidney D., *Southern Pulp Paper Mfr.* 11, No. 10A: 56, 58, 60, 62, 64, 66 (Oct. 31, 1948); *B.I.P.C.* 19: 225.
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153. Wells, Sidney D., *Southern Pulp Paper Mfr.* 15, No. 10: 42, 46, 48, 50, 52, 54, 59, 62–64, 66 (Oct. 1, 1952); *Tappi* 35, No. 10: 42A, 44A, 46A, 48A, 50A, 52A, 54A, 56A, 58A, 60A, 62A, 64A, 66A (Oct., 1952); *B.I.P.C.* 23: 159.
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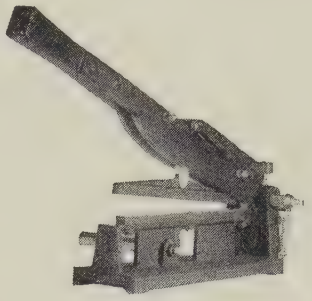

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Feb. 22–25, 1960

UNITED STATES PATENTS ON PAPERMAKING

First Quarter, 1959 — *Compiled by The Institute of Paper Chemistry*

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired. Or, those desiring the patents on *microcards* should write to The Institute of Paper Chemistry, Appleton, Wis.

January 6, 1959

Andre, Noble. Carrier for cans. U. S. patent 2,867,320. Filed Dec. 28, 1953. 6 claims. Assigned to Andre-Matic Machinery Co. [Cl. 206-65.]

Andresen, William F., Jr., and Schempp. Roy. Automatic box wrapping system. U. S. patent 2,867,158. Filed April 4, 1955. 21 claims. Assigned to Food Machinery and Chemical Corp. [Cl. 93-54.]

Bartlett, Francis J. W. Method of applying patterns to vinyl floor coverings. U. S. patent 2,867,263. Filed April 4, 1955. 4 claims. Assigned to Francis John Woodford Bartlett. [Cl. 154-26.] A method is described for making a decorative vinyl surface layer for application to an impregnated felt in the manufacture of floor coverings.

Bennett, Geoffrey E. Electric cables and condenser insulation including wax and petroleum. U. S. patent 2,867,596. Filed July 26, 1954. 5 claims. Assigned to Dussek Bro. & Co. Ltd. [Cl. 260-27.] A composition is provided for impregnating paper tape for use in insulating electric cables.

Benzon-Petersen, Boye. Device for producing containers sealed with covers. U. S. patent 2,867,159. Filed May 13, 1955. 7 claims. Assigned to Aktiebolaget Akerlund & Rausing. [Cl. 93-36.] The apparatus provided heat-seals the end flaps of a rectangular tubular carton to form a closure.

Bramante, Nunzio. Holder for milk container. U. S. patent 2,867,364. Filed March 22, 1957. 1 claim. (Cl. 224-45.] A handled holder is provided for supporting a paperboard milk carton during use.

Butz, James N. Corner packing. U. S. patent 2,867,367. Filed July 16, 1956. 5 claims. Assigned to Continental Can Co., Inc. [Cl. 229-14.] A corrugated board blank folds into an interior packing element for use in shipping containers.

Cernera, Charles C. Containers for cigarettes. U. S. patent 2,867,369. Filed June 21, 1954. 2 claims. [Cl. 229-20.] A flat cigarette box is modified to give it a curved pocket-fitting shape.

Costello, James R., Jr. Methods of flameproofing fibers, compositions used therein. U. S. patent 2,867,597. Filed Sept. 22, 1953. 4 claims. Assigned to Victor Chemical Works. [Cl. 260-29.6.] This is similar to U. S. patent 2,867,547 (Jan. 6, 1959).

Dillingham, Frederick L. Debarking rotor having cushioned flails. U. S. patent 2,867,252. Filed Aug. 29, 1956. 10 claims. Assigned to Soderhamn Machine Mfg. Co. [Cl. 144-208.]

Fox, Richard M. Bag structure with pocket. U. S. patent 2,867,372. Filed Oct. 5, 1955. 2 claims. Assigned to The O. M. Scott & Sons Co. [Cl. 229-56.] A multi-ply paper bag is provided with a pocket for an instruction leaflet or the like.

Hall, Charles T. Methods of and means for wrapping block-shaped articles. U. S. patent 2,867,065. Filed Sept. 11, 1956. 5 claims. Assigned to Molins Machine Co. Ltd. [Cl. 53-170.] The machine wraps a block of cigarettes.

Hauck, Edwin J., and Suda, Stanley. Apparatus for the recovery of heat and chemicals. U. S. patent 2,867,195. Filed May 9, 1955. 5 claims. Assigned to the Babcock & Wilcox Co. [Cl. 122-240.] In the furnace provided, one combustion chamber burns black liquor, the other fuel oil or gas, with both chambers acting on a single steam-generating unit.

Herrmann, Alvin G. Apparatus for making stencils. U. S. patent 2,867,155. Filed Jan. 28, 1955. 7 claims. [Cl. 93-1.]

Holtzmann, Norman. Display boxes. U. S. patent 2,867,048. Filed May 2, 1955. 14 claims. Assigned to Paper Mate Mfg. Co. [Cl. 40-7.] A sliding extendable display panel is provided.

Hori, Tatsu. Paper-stacking device. U. S. patent 2,867,438. Filed Oct. 19, 1956. 13 claims. Assigned to General Electric Co. [Cl. 271-74.] A suction cylinder is employed to receive sheets of paper, transfer them a short distance, and add them to a stack of the sheets.

Hornbostel, Lloyd. Lubrication system. U. S. patent 2,867,481. Filed Oct. 17, 1955. 8 claims. [Cl. 308-187.] An improved automatic lubrication system is provided for heavy duty bearings such as those of a paper machine.

Kaplan, Mitzi. Cigarette carton. U. S. patent 2,867,368. Filed April 24, 1958. 2 claims. [Cl. 229-17.] Improved opening means are provided.

Kaufmann, Milton M. Double letter envelope. U. S. patent 2,867,373. Filed April 1, 1955. 5 claims. [Cl. 229-73.] A one-piece paper blank is formed into a mailing device which includes both sending and return writing spaces and envelopes.

Klasing, Arthur P. Machines for making vacuum cleaner bags. U. S. patent 2,867,183. Filed Dec. 12, 1957. 13 claims. Assigned to Central States Paper & Bag Co. [Cl. 112-10.]

Kulka, Thomas S. Combined housing and tape retaining means for tape holding reels. U. S. patent 2,867,318. Filed March 16, 1955. 1 claim. [Cl. 206-59.] A paperboard container is provided for housing a reel of magnetic recording tape or motion picture film.

La Tourette, Harry B., Jr. Container. U. S. patent 2,867,365. Filed Feb. 15, 1954. 2 claims. [Cl. 229-1.5.] A handled paper cup for a beverage carries a spoon detachably secured to the cup side wall.

Lehmann, René L., and Gandon, L. Preparation of glyoxalated compounds of starch. U. S. patent 2,867,615. Filed Dec. 28, 1955. 10 claims. Assigned to Bozel-Maletra, Sociéte Industrielle de Produits Chimiques. [Cl. 260-233.3.] The film-forming adhesive composition has various papermaking uses.

Maloney, James D., Jr., and Brown, Clinton B. Chilling roll for paper coating machines. U. S. patent 2,867,414. Filed Dec. 23, 1955. 1 claim. Assigned to The Mead Corp. [Cl. 257-95.]

Mitchell, George E. Printing mechanism. U. S. patent 2,867,167. Filed Dec. 27, 1956. 6 claims. Assigned to International Business Machines Corp. [Cl. 101-47.] Both sides of a postcard are imprinted at the same printing station on one pass of the card through the machine.

Moore, Marietta T. Machine for forming package trays. U. S. patent 2,867,157. Filed Sept. 27, 1954. 12 claims. [Cl. 93-37.] A partitioned paperboard tray is formed.

Nyden, Robert. Boxes having flexibility hinged covers. U. S. patent 2,867,371. Filed Aug. 10, 1955. 5 claims. [Cl. 229-44.]

O'Reilly, Joseph A. Multi-cellular carton. U. S. patent 2,867,370. Filed Jan. 23, 1956. 3 claims. [Cl. 229-28.] This is a hinged lid egg carton formed from a single blank.

Othmer, Donald F. Process for recovering volatile aliphatic acids. U. S. patent 2,867,655. Filed Feb. 20, 1957. 4 claims. [Cl. 260-527.] Acetic and formic acids and the like are recovered from spent pulping liquors.

Outterson, Charles R. Process for flameproofing paper. U. S. patent 2,867,549. Filed March 6, 1956. 13 claims. Assigned to The Albemarle Paper Mfg. Co. [Cl. 117-137.] The paper is impregnated with a suspension of rosin in a solution of flameproofing salts such as ammonium sulphate.

Platt, John D., Platt, Leland, H., Jr., and Platt, Leland H. Apparatus for closing flexible bags. U. S. patent 2,867,067. Filed March 13, 1957. 25 claims. [Cl. 53-198.] The apparatus provided gathers the neck of a large-sized bag filled with produce and tapes the gathered neck with pressure-sensitive tape.

Platt, Leland H. Bag closing apparatus. U. S. patent 2,867,066. Filed Dec. 12, 1955. 10 claims. [Cl. 53-198.] This is similar to U. S. patent 2,867,067 (Jan. 6, 1959).

Roberts, Elliott J. Producing sulphur dioxide gas. U. S. patent 2,867,506. Filed July 18, 1956. 1 claim. (Cl. 23-177.]

Sharples, Edwin H. Process for the recovery of zinc sulphate from solutions of zinc sulphate and magnesium sulphate. U. S. patent 2,867,496. Filed Dec. 3, 1954. 3 claims. Assigned to Courtaulds Ltd. [Cl. 18-54.]

Streeter, Clifford J., and Kadoun, Kenneth R. Device for holding down flaps of cardboard boxes. U. S. patent 2,867,019. Filed March 5, 1956. 3 claims. [Cl. 24-81.]

Toy, Arthur D. F., and Cooper, Robert S. Method of flameproofing fibers, compositions used therein and the resulting products. U. S. patent 2,867,547. Filed Sept. 22, 1953. 16 claims. Assigned to Victor Chemical Works. [Cl. 117-136.] This is similar to U S. patent 2,867,548 (Jan. 6, 1959).

Toy, Arthur D. F., and Cooper, Robert S. Method of flameproofing fibers, compositions used therein and the resulting products. U. S. patent 2,867,548. Filed Sept. 22, 1953. 27 claims. Assigned to Victor Chemical Works. [Cl. 117-136.] The flameproofing impregnant is a polymerized β, γ-unsaturated dialkenyl-β-cyanoethanephosphonate.

Uhlenkott, John J. Log-handling device. U. S. patent 2,867,316. Filed Sept. 6, 1957. 3 claims. [Cl. 203-75.] Improved log-feeding means are provided in a log barker.

Vogt, Clarence W. Method and apparatus for preventing slippage of tape rolls and resulting product. U. S. patent 2,867,317. Filed Sept. 21, 1953. 7 claims. [Cl. 206-59.] The pressure-sensitive adhesive layer is deformed in a herringbone pattern to prevent slippage between layers.

Whiton, Arthur L., and Byers, Ralph J. Crate. U. S. patent 2,867,366. Filed July 25,1955. 3 claims. Assigned to Chicoga Mill & Lumber Co. [Cl. 229-14.] A wooden skid and wood-reinforced corrugated board body portion are combined to provide an appliance-shipping crate.

January 13, 1959

Anderson, Wilbur G., Jr. Handle receptacle. U. S. patent 2,868,433. Filed May 3, 1956. 6 claims. Assigned to American Box Board Co. [Cl. 229-52.] The outer upper glue flap of a paperboard carton is modified so that it provides a integral carrying handle for the carton.

Augery, Jean., and Bouisset, Fernand. Paper-gumming machines. U. S. patent 2,868,157. Filed May 29, 1956. 2 claims. Assigned to Societe Anonyme Dite: "La Charfa." [Cl. 118-8.]

Baker, Edgar B. Method of improving soil. U. S. patent 2,868,758. Filed Dec. 2, 1953. 3 claims. Assigned to Stauffer Chemical Co. [Cl. 260-41.] Among the compounds used are carboxymethylcellulose lignosulphonates, pine sawdust, redwood bark, etc.

Burnham, Robert R. Corrosive resistant polyethylene emulsions. U. S. patent 2,868,742. Filed April 16, 1956. 2 claims. Assigned to Union Carbide Corp. [Cl. 260-17.] Hydroxyethylcellulose is used in compounding a textile-treating dispersion.

Cunder, Joseph, and Licata,Francis J. Aluminum soap waterproofing composition and process of making the same. U. S. patent 2,868,666. Filed Dec. 11, 1956. 9 claims. Assigned to Nopco Chemical Co. [Cl. 106-243.] The composition is of use in waterproofing paper and board.

Depew, Harlan A., Quinn, Patrick D., and Waitkins, George R. Treatment of materials. U. S. patent 2,868,673. Filed March 7, 1958. 20 claims. Assigned to American Zinc, Lead & Smelting Co. [Cl. 117-137.] Paper and other cellulosic materials are treated to improve resistance to fire, acids, water, insects, and microorganisns.

Downs, Martin L., and Schmitt, Milton G. Paper and method of making same. U. S. patent 2,868,685. Filed July 26, 1954. 6 claims. Assigned to Thilmany Pulp & Paper Co. [Cl. 154-138.] Paper sheets are laminated with asphalt or the like without bleeding of the laminating agent through the paper.

Eilbeck, Gorman E., and Urig, Elmer R. Stable latex composition comprising carboxyl-containing elastomer and alkali/-metal/aluminate or the like as water-soluble curing agent. U. S. patent 2,868,754. Filed June 29, 1955. 5 claims. Assigned to B. F. Goodrich Co. [Cl. 260-29.7.] The composition is of use in impregnating paper.

Ernst, Earl A. Sacking device. U. S. patent 2,868,245. Filed March 26, 1956. 7 claims. [Cl. 141-248.] A machine for bagging graded produce is provided.

Feigley, David A., Jr. Beater saturated sheets having increased strength. U. S. patent 2,868,641. Filed July 20, 1956. 20 claims. Assigned to Armstrong Cork Co. [Cl. 92-21.] A synthetic rubber beater-saturation process is rendered more effective by also adding sodium polyacrylate.

Fischer, Walter. Container and closure for the same. U. S. patent 2,868,435. Filed Feb. 14, 1955. 3 claims. Assigned to Getreideflocken A.-G. [Cl. 229-66.] A paper bag closure comprises a paper strip folded over the bag mouth edges and enclosing a wire or other similar strip material in the fold adjacent the bag mouth edges.

Frey, Raymond M. Furan resin compositions including tall oil and an aromatic aldehyde. U. S. patent 2,868,747. Filed Nov. 4, 1955. 9 claims. Assigned to McGraw-Edison Co. [Cl. 260-23.5.]

Goldstein, Arthur M. Dry mannogalactan composition. U. S. patent 2,868,664. Filed May 3, 1954. 5 claims. Assigned to Stein, Hall & Co., Inc. [Cl. 106-208.] A readily dispersible pulp additive is provided.

Groenhuis, Harm. Packing tube. U. S. patent 2,868,437. Filed April 22, 1954. 4 claims. Assigned to North American Philips Co., Inc. [Cl. 229-90.] Inner and outer tubes of paper, one smooth and one corrugated, form a shipping container for eggs.

Guyer, Reynolds. Cartons with tear openers. U. S. patent 2,868,432. Filed June 11, 1956. 6 claims. Assigned to Waldorf Paper Products Co. [Cl. 229-51.]

Hamilton, Joseph P. Stacking paperboard tray. U. S. patent 2,868,430. Filed Aug. 7, 1956. 8 claims. Assigned to Container Corp. of America. [Cl. 229-34.] This is a stackable open-topped paperboard tray for berries and the like.

Henricks, John A. Process of lubrication. U. S. patent 2,868,671. Filed Nov. 14, 1951. 8 claims. Assigned to Devex Corp. [Cl. 117-97.] Cellulose esters of boric, arsenic, and phosphoric acids are used in the lubrication of metal surfaces.

Howard, Thomas P. Packaging machine. U. S. patent 2,868,375. Filed Dec. 9, 1954. 8 claims. Assigned to Pneumatic Scale Corp. [Cl. 209-121.] The machine fills cartons with accurately weighed loads.

Ingham, Philip H., and Mastrobattista, Arthur. Pigmented plastics and method for preparing the same. U. S. patent 2,868,662. Filed Feb. 23, 1954. 11 claims. Assigned to Interchemical Corp. [Cl. 106-193.] A process for the plastic milling of pigments into cellulose acetate is described.

Jones, Forest E. Paper cup handle. U. S. patent 2,868,434. Filed Aug. 23, 1957. 6 claims. [Cl. 229-52.]

Kesselman, Jacob. Holder for milk cartons or the like. U. S. patent 2,868,411. Filed March 5, 1957. 4 claims. [Cl. 220-85.] Nestable molded plastic holders are provided for paperboard milk cartons and similar containers.

Kolodziej, Edwin S. Apparatus for improved control of paper web position. U. S. patent 2,868,541. Filed March 11, 1957. 8 claims. Assigned to R. R. Donnelley & Sons Co. [Cl. 271-2.6.] A printing press is provided with web sidelay registration means.

Koons, George I., Boule, George P., and Swanson, Kermit E. Method and apparatus for forming signatures. U. S. patent 2,868,539. Filed Oct. 19, 1955. 6 claims. Assigned to R. R. Donnelley & Sons Co. [Cl. 270-41.]

Kreft, Leon J. Emergency splint compress. U. S. patent 2,868,193. Filed Jan. 18, 1954. 5 claims. Assigned to Aram Tashjian. [Cl. 128-89.] A creped paper pad is used in forming a first-aid device.

Legnaioli, Louis F. Cigarette package. U. S. patent 2,868,-363. Filed March 7, 1957. 5 claims. [Cl. 206-41.] A sheet of memo paper and a pencil-like device are included.

Loew, Harold L., Oddo, Rocco R., and Ruben, Robert M. Dispensers for containers. U. S. patent 2,868,415. Filed Dec. 16, 1955. 11 claims. [Cl. 222-90.] A metal or plastic device is provided for attachment to a carton wall as a dispensing device.

McFaul, Claude F. Combination matchbook and throw-away ash tray. U. S. patent 2,868,362. Filed Nov. 22, 1955. 1 claim. Assigned to Claude McFaul Corp. [Cl. 206-38.]

McManus, Albert R. An impregnated corrugated paperboard, a composition therefor, and a process of making said composition. U. S. patent 2,868,665. Filed March 7, 1957. 6 claims. [Cl. 106-230.] Impregnation with paraffin and limed rosin increases the strength and water resistance of the board.

Mattingly, Ralph J., and Mattingly, John J. Can labeler. U. S. patent 2,868,403. Filed Jan. 20, 1955. 7 claims. [Cl. 216-58.]

Minkema, William H. Preparation of starch esters. U. S. patent 2,868,780. Filed April 23, 1957. 7 claims. Assigned to Corn Products Refining Co. [Cl. 260-233.5.]

Murrell, Harvey S. Tapered tube forming and applying mechanism. U. S. patent 2,867,956. Filed July 3, 1953. 7 claims. [Cl. 53-296.] The machine forms hollow truncated cones from a web of paper or paper-metal foil laminate and applies the products as labels to the necks of bottles.

Paige, Richard E. Convertible receptacle for shipping and display. U. S. patent 2,868,365. Filed Oct. 4, 1954. 17 claims. [Cl. 206-45.] The "receptacle" is a corrugated board whiskey case.

Painter, Jack L. Boxes. U. S. patent 2,868,431. Filed March 16, 1955. 3 claims. Assigned to Crown Zellerbach Corp. [Cl. 229-51.] A corrugated board can case is provided with a tear-tape-opened access port in one side wall.

Patten, Lorraine E., and Kelly, Harold C. Method of coating foods articles and product obtained thereby. U. S. patent 2,868,-656. Filed Dec. 23, 1957. 18 claims. Assigned to the Dow Chemical Co. [Cl. 99-166.] Ethylcellulose is used.

Perry, J. H. Tape dispenser. U. S. patent 2,868,402. Filed May 29, 1958. 13 claims. [Cl. 216-29.]

Phillips, Edwin D. Polishing pad and method of making the same. U. S. patent 2,867,954. Filed Sept. 26, 1956. 9 claims. [Cl. 51-195.] A paper-base lens-polishing pad is provided.

Poppe, George W. Paper bag with locking element having

concealed ends. U. S. patent 2,868,436. Filed April 30, 1956. 9 claims. Assigned to Equitable Paper Bag Co., Inc. [Cl. 229-77.]

Schmied, Joseph M. Method and apparatus for setting up box blanks. U. S. patent 2,868,093. Filed June 14, 1957. 20 claims. Assigned to St. Regis Paper Co. [Cl. 93-49.]

Shanahan, Curtis M. Paperboard tray. U. S. patent 2,868-429. Filed Nov. 14, 1956. 1 claim. Assigned to Container Corp. of America. [Cl. 229-30.] Improved stacking strength is provided in a bakery goods tray of the type intended for overwrapping after filling.

Thorpe, Lawrence R. Display package. U. S. patent 2,868,-371. Filed July 12, 1957. 3 claims. [Cl. 206-79.] A display holder for a ready-knotted necktie is provided.

Watson, Stanley A., and Williams Carl B. Process for extracting hemicellulose from corn coarse fiber. U. S. patent 2,868,-778. Filed April 21, 1954. 6 claims. Assigned to Corn Products Refining Co. [Cl. 260-209.]

Webb, Nelson W. Fourdrinier wire package. U. S. patent 2,868,369. Filed July 24, 1957. 13 claims. Assigned to Eastwood-Nealley Corp. [Cl. 206-59.] Pressure-sensitive tape is rolled up with the wire to prevent slipping of the coils.

White, Howard J., Jr., and Cates, David M. Cellulose containing polymeric materials and method of producing the same. U. S. patent 2,868,744. Filed April 7, 1953. 12 claims. Assigned to Textile Research Institute. [Cl. 260-17.4.] A method is described for preparing cellulose fibers and films from a composition including a cellulose ester and polyvinyl chloride or polyacrylonitrile.

Zolyn, Kazimir S. Tote box. U. S. patent 2,868,405. Filed July 15, 1957. 1 claim. Assigned to White Industries Inc. [Cl. 217-15.] A collapsible tote box is formed of corrugated board supported on a wooden frame.

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Backhouse, Headley T. Sheet separating machine. U. S. patent 2,869,867. Filed Dec. 21, 1954. 12 claims. [Cl. 217-26.]

Bass, Helen L. Lunchbox construction. U. S. patent 2,869,-770. Filed June 8, 1956. 3 claims. Assigned to Amalgamated Bass Prince Inventions, Inc. [Cl. 229-27.] A single blank sets up to form a handled compartmented aluminum foil-lined paperboard lunch box for children.

Bauer, Charles H. Sheet feeding apparatus. U. S. patent 2,869,869. Filed May 17, 1955. 2 claims. Assigned to International Business Machines Corp. [Cl. 271-36.] Punched cards are fed to a computer without burring the edges of the cards.

Baumer, Earl F. Single-void unitized transportable package. U. S. patent 2,869,721. Filed Oct. 18, 1957. 2 claims. [Cl. 206-65.] Corrugated board is used as protective padding in a branded unitized load of bricks.

Bothwell, Willaim R. Box handle. U. S. patent 2,869,771. Filed April 1, 1957. 9 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 229-52.] A plastic handle locks box and telescoping cover in closed condition.

Burgmer, Josef. Apparatus for the assembly and finishing of sets of duplicating forms. U. S. patent 2,869,864. Filed June 10, 1957. 4 claims. [Cl. 270-52.]

Buschmann, Walter, and Bühren, Walter. Process for drying sheet material with air. U. S. patent 2,869,246. Filed April 25, 1956. 3 claims. Assigned to J. P. Bemburg A.-G. [Cl. 34-23.] An air-jet drier for webs of cellulose film or other material is designed to prevent excessive drying near the edges of the web.

Chance, Leon H., Drake, George L., Jr., and Reeves, Wilson A. Flame resistant organic textiles and method of production. U. S. patent 2,870,042. Filed April 24, 1957. 15 claims. Assigned to U. S. Secretary of Agriculture. [Cl. 117-136.] Paper etc., are impregnated with a mixture of a 1-aziridinyl compound and an alcohol to effect flameproofing.

Cowan, Ben. Agitator for pulp stock tanks. U. S. patent 2,869,841. Filed Sept. 19, 1955. 2 claims [Cl. 259-96.]

Giesen, Johann. Production of phenols by catalytic hydrogenation of lignin. U. S. patent 2,870,133. Filed Oct. 19, 1954. 4 claims. Assigned to Inventa A.-G., für Forschung und Patentverwertung Luzern. [Cl. 260-124.]

Gill, Edwin R., Jr. Coated manifolding sheets and method of making them. U. S. patent 2,870,040. Filed Aug. 6, 1957. 12 claims. [Cl. 117-36.] The coatings employed eliminate the need for carbon paper.

Hall, Carroll, B., Perry, Newell A., and Zullig, Max F. Low viscosity sulfurized tall oil and process for making the same. U. S. patent 2,870,132. Filed Jan. 22, 1957. 4 claims. Assigned to Ridbo Laboratories, Inc. [Cl. 260-97.5.]

Hergert, Herbert L. Process for recovering flavonoids from bark. U. S. patent 2,870,165. Filed June 20, 1956. 8 claims. Assigned to Rayonier Inc. [Cl. 260-345.2.]

Hornbostel, Lloyd, Beachler, Edward D., and Ely, Donald A. Paper machine press section. U. S. patent 2,869,437. Filed Sept. 15, 1955. 21 claims. Assigned to Beloit Iron Works. [Cl. 92-49.] A suction transfer arrangement is described.

Hubbard, James K., and Koontz, Franklin H. Synthetic paper sheet of chemically bonded synthetic polymer fibers and process of making the same. U. S. patent 2,869,973. Filed Aug. 25, 1954. 14 claims. Assigned to E. I. du Pont de Nemours & Co. [Cl. 8-130.1.]

Justus, Edgar J. Condensate removal control for paper machine dryers. U. S. patent 2,869,248. Filed Oct. 17, 1955. 5 claims. Assigned to Beloit Iron Works. [Cl. 34-54.]

Kraft, George H., Grossen, Harry W., and Bell, Kenneth. Wrapper feed mechanism. U. S. patent 2,869,868. Filed June 19, 1951. 6 claims. Assigned to National Dairy Products Corp. [Cl. 271-31.]

Lander, James G. Adhesive compositions. U. S. patent 2,870,033. Filed March 19, 1954. 11 claims. Assigned to Diamond Alkali Co. [Cl. 106-82.] A urea-silicate-cottonseed oil adhesive is provided for use in making corrugated board.

McReynolds, Robert W. Method and apparatus for coating a surface with lightweight aggregate. U. S. patent 2,870,039. Filed Aug. 31, 1953. 2 claims. Assigned to Augustine Richard Moulin. [Cl. 117-28.] The apparatus provided spray-coats a paper sheet with a resin admixed with sawdust or the like to form an insulation material.

Mahoney, James A. Package for incandescent lamps. U. S. patent 2,869,720. Filed April 12, 1956. 1 claim. [Cl. 206-65.]

Marander, Myron P., Gschwend, Felix B., and Smith, Monroe F. Paper products having a release coating and method of preparation thereof. U. S. patent 2,869,722. Filed Oct. 14, 1957. 7 claims. Assigned to Fibreboard Paper Products Corp. [Cl. 206-84.] A silicone resin-polyvinyl alcohol release coating is applied to paperboard shipping containers for rubber, asphalt, and the like.

Martin, Menno G. Payroll record and computing papers. U. S. patent 2,869,898. Filed Oct. 14, 1955. 5 claims. Assigned to Shaw-Walker Co. [Cl. 282-27.]

Moore, Robert S. Non-volatile mercaptan and hydroxyamine impregnated end wrap and method of use. U. S. patent 2,869,559. Filed Oct. 7, 1957. 12 claims. Assigned to Procter & Gamble Co. [Cl. 132-7.] An impregnated flax paper is provided for use in cold waving hair.

Morin, Louis H. Machine for milling slots in fanfold paper towels. U. S. patent 2,869,430. Filed March 14, 1955. 1 claim. Assigned to West Chemical Products Inc. [Cl. 90-16.]

Neer, Clifford H. Method and apparatus for casing merchandise. U. S. patent 2,869,297. Filed Jan. 31, 1955. 21 claims. Assigned to Maryland Engineering Co. [Cl. 53-26.] The machine loads a can case.

Overman, Earl R. Two-stage bagging machine. U. S. patent 2,869,296. Filed July 31, 1956. 20 claims. [Cl. 53-24.] The machine compresses a charge of rock wool or the like, then packages the charge in a bag.

Reynolds, William B., and Carpenter, Paul G. Synthetic rubber composition containing rosin acid and dithiocarbamate accelerating agent and method of producing same. U. S. patent 2,870,107. Filed Sept. 18, 1953. 15 claims. Assigned to Phillips Petroleum Co. [Cl. 260-27.]

Rice, Livingston L., Lamphier, Walter C., and Netherwood, Paul H. Impregnated electrical capacitors. U. S. patent 2,870,385. Filed Feb. 2, 1956. 3 claims. Assigned to Sprague Electric Co. [Cl. 317-258.] The capacitor comprises two or more metallized papers impregnated with a mixture of an isobutylene interpolymer and microcrystalling wax.

Richter, Johan C. F. C. Method and apparatus for the separation of liquids from cellulosic pulp. U. S. patent 2,870,009. Filed June 8, 1956. 1 claim. Assigned to AB. Kamyr. [Cl. 92-7.] A continuous pulping system accomplishes the separation of steam and gases from the pulp and discharge of the pulp without the dilution of the pulp with water.

Ridgway, Eric O. Chloroprene rubber composition containing a tall oil-sulphur reaction product. U. S. patent 2,870,104. Filed July 31, 1953. 5 claims. Assigned to Ridbo Laboratories, Inc. [Cl. 260-23.7.]

Ridgway, Eric O., and Perry, Newell A. Chloroprene rubber compositions containing sulfurized tall oil. U. S. patent 2,870,-106. Filed July 31, 1953. 3 claims. Assigned to Ridbo Laboratories, Inc. [Cl. 260-23.7.]

Ridgway, Eric O., and Perry, Newell A. Nitrile rubber compositions containing sulfurized tall oil. U. S. patent 2,870,105. Filed July 31, 1953. 3 claims. Assigned to Ridbo Laboratories, Inc. [Cl. 260-23.7.]

Sands, Seymour. Process and product. U. S. patent 2,869,-435. Filed Jan. 3, 1956. 10 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 92-3.] Synthetic fibers such as polyhexamethylene adipamide fibers are formed into an aqueous suspension suitable for formation into paper.

Scott, Robert F. Apparatus for packaging flat flexible articles. U. S. patent 2,869,302. Filed Dec. 26, 1956. 17 claims. [Cl

53-255.] Sheets of paperboard carrying shingled strips of bacon are inserted into paper or cellophane bags or envelopes.

Sheeran, Norman J. Laminating adhesive and method of producing the same. U. S. patent 2,870,034. Filed April 1, 1957. 8 claims. Assigned to American-Marietta Co. [Cl. 106-124.] A clay and blood adhesive is provided for laminating paper to paper or paper to wood.

Shurtliff, Norval E. Logging cable haulback apparatus. U. S. patent 2,869,822. Filed Jan. 15, 1952. 1 claim. [Cl. 254-150.]

Stewart, Alexander E. Stock cross-flow distribution. U. S. patent 2,869,436. Filed June 7, 1957. 13 claims. Assigned to Dominion Engineering Works Ltd. [Cl. 92-44.] The apparatus distributes paper stock to the headbox of a paper machine so that uniform conditions of stock mass and flow are established across the width of the headbox.

Stobb, Anton R. Signature stitching, folding and trimming mechanism. U. S. patent 2,869,863. Filed May 25, 1956. 14 claims. Assigned to Western Printing & Lithographing Co. [Cl. 270-37.]

Vandenburgh, Charles D. Liquid and gas separator. U. S. patent 2,869,674. Filed May 13, 1955. 5 claims. Assigned American Viscose Corp. [Cl. 183-2.5.] In the apparatus provided, a spinning bath solution which has been used to coagulate viscose is freed of gases such as hydrogen sulphide.

Vogt, Clarence W. Enwrapments for plastic and like substances. U. S. patent 2,870,023. Filed July 5, 1951. 7 claims. [Cl. 99-179.] A butter stick wrapper formed of a kraft paper-reinforced foil-parchment paper laminate is designed to permit attachment of the wrapped stick to other similar packages.

Wagenfeld, Gilbert B. Sanitary head covering. U. S. patent 2,869,135. Filed Sept. 12, 1956. 7 claims. [Cl. 2-174.] A paper hat is provided, similar to that worn by waitresses and the like.

Wang, Wensan. Disposable all-weather hat. U. S. patent 2,869,136. Filed Nov. 9, 1956. 2 claims. [Cl. 2-177.] The hat is made of waterproof paper or other suitable material.

Watson, William M. Machine for attaching handles to cartons. U. S. patent 2,869,438. Filed Sept. 20, 1954. 5 claims. Assigned to Paper Strap, Inc. [Cl. 93-36.]

Westervelt, John C. Fixer for electrostatic photography. U. S. patent 2,870,312. Filed March 18, 1957. 1 claim. Assigned to Century Geophysical Corp. [Cl. 219-19.] The apparatus provided fixes photographic images on a web of recording paper without charring the paper.

Whelan, James P. Infusion bag. U. S. patent 2,869,718. Filed Sept. 14, 1956. 2 claims. Assigned to Pneumatic Scale Corp., Ltd. [Cl. 206-.5.] The string handle and tag are arranged so as to prevent tangling.

Wilcox, William H. Carton setting up machine. U. S. patent 2,869,439. Filed Dec. 9, 1954. 32 claims. Assigned to Fibreboard Paper Products Corp. [Cl. 93-49.] The cartons are of a traylike type; the setting up is accomplished as the carton is moved from a supply hopper to subsequent conveyor means.

Williams, Russell J. Bag. U. S. patent 2,869,772. Filed March 26, 1956. 7 claims. Assigned to Bemis Bro. Bag Co. [Cl. 229-55.] A multi-ply bag is reinforced to compensate for the weakness caused by the formation of the end closure.

Winters, Kauno W., and Oja, George E. Log handling arm attachment for trucks. U. S. patent 2,869,741. Filed Dec. 17, 1957. 1 claim. [Cl. 214-92.]

Wolinski, Leon E. Printable polyethylene film. U. S. patent 2,870,043. Filed June 3, 1954. 2 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117-138.8.]

Zerlin, Hans, and Michaelis, Heinz. Method of and apparatus for making polygonal containers of paper, cardboard of the like. U. S. patent 2,869,440. Filed July 19, 1955. 11 claims. Assigned to Jargen-Werke A.-G. [Cl. 93-55.1.] These are tapered-side milk containers.

Zwoyer, Walter R. Automatic packaging machine. U. S. patent 2,869,298. Filed Jan. 15, 1954. 17 claims. Assigned to Package Machinery Co. [Cl. 53-51.] The machine forms packages from a tube of packaging material so that each package carries a precisely located printed design or indicia.

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Alberda, Gerrit. Process for the extraction of alkali metal salts of vanillin or its higher homologues from alkaline process liquors. U. S. patent 2,871,270. Filed Nov. 4, 1957. 5 claims. Assigned to N. V. Nederlandsche Combinatie voor Chemische Industrie. [Cl. 260-600.]

Bailey, William R. Supporting members. U. S. patent 2,870,793. Filed Feb. 8, 1955. 1 claim. Assigned to Gar Wood Industries. [Cl. 138-78.] An inner tube of kraft board and an outer sheath of glass fibers form a utility pole or other supporting member.

Bernad, Jacques J., Novion, Armand, and Lablache-Combier, Michel J. Apparatus for stocking small logs and picking up same from a stock for loading vehicles. U. S. patent 2,870,925. Filed March 6, 1957. 8 claims. Assigned to Societe Anonyme dite: Société Auxiliaire de l'Enterprise "Auxen." [Cl. 214-147.]

Blair, Robert C. Manufacture of cellular structures. U. S. patent 2,870,694. Filed Dec. 8, 1954. 9 claims. Assigned to British Plaster Board (Holdings) Ltd. [Cl. 93-37.] Paperboard partitioning elements are formed for use in egg cartons or as core material in building units.

Brady, Charles V., and Ottinger, August F. Bag. U. S. patent 2,870,955. Filed July 5, 1955. 2 claims. Assigned to Bemis Bro. Bag Co. [Cl. 229-66.] Means are provided to facilitate the tearing open of a multi-ply paper bag along the needle holes formed by the stitched end closure of the bag.

Brennan, Joseph B., and Brennan, Helen E. Method of producing strip material. U. S. patent 2,870,689. Filed Dec. 4, 1952. 9 claims. [Cl. 92-41.] A metal-bonded inorganic paper is provided for use in condensers and the like.

Corbin, Wesley S., and Walden, Henrik. Head box for paper making machines. U. S. patent 2,870,690. Filed Nov. 6, 1952. 11 claims. Assigned to The Black-Clawson Co. [Cl. 92-44.]

Currivan, John F. Cartons. U. S. patent 2,870,949. Filed Nov. 30, 1954. 11 claims. [Cl. 229-14.] A collapsible protective carton is provided for packaging fragile articles such as vacuum tubes.

Etheridge, Oliver R. Starch pasting system. U. S. patent 2,871,146. Filed Feb. 24, 1954. 10 claims. Assigned to A. E. Staley Mfg. Co. [Cl. 127-28.]

Gard, George E. Method of drying fibrous boards. U. S. patent 2,870,544. Filed Jan. 24, 1956. 2 claims. Assigned to Armstrong Cork Co. [Cl. 34-1.]

Getting, Milan P., Jr. Magnetic material provided with separator coating. U. S. patent 2,871,143. Filed June 29, 1956. 3 claims. Assigned to Allis-Chalmers Mfg. Co. [Cl. 117-127.] Carboxymethylhydroxyethylcellulose is used.

Goldstein, Eugene E. Translucent acoustical correction ceiling construction. U. S. patent 2,870,857. Filed March 6, 1956. 10 claims. Assigned to Celotex Corp. [Cl. 181-33.] Resin-impregnated paper may be used in forming the acoustical unit.

Henkin, Hyman. Shampoo compositions. U. S. patent 2,871,193. Filed Sept. 6, 1955. 8 claims. Assigned to Colgate-Palmolive Co. [Cl. 252-152.] Hydroxypropylmethylcellulose is used.

Inman, William H. Carton. U. S. patent 2,870,950. Filed April 24, 1957. 7 claims. Assigned to Bloomer Bros. Co. [Cl. 229-16.] A one-piece paperboard ice cream pail of the type having an inverted frustopyramidal form is constructed to permit easy reclosing.

Jacobs, Robert J., and Persson, Edward E. Paper coating machine. U. S. patent 2,870,738. Filed Feb. 28, 1957. 1 claim. Assigned to Black-Clawson Co. [Cl. 118-249.] This is a flexible machine, handling a variety of coating compositions, either in on or off machine coating, by either direct or reverse coating methods.

Jilovice, Vladimir J. H. Process for obtaining polysaccharide material from plants of the genus "Cecropia." U. S. patent 2,871,235. Filed Aug. 12, 1953. 17 claims. [Cl. 260-209.]

Kulesza, Chester P. Vacuum package. U. S. patent 2,870,954. Filed May 15, 1956. 1 claim. Assigned to Reynolds Metals Co. [Cl. 229-62.5.] A bag of a paper-aluminum foil laminate is provided with a valve device which permits vacuumizing the bag.

Kwitek, Edwin M. Web cutting apparatus. U. S. patent 2,870,840. Filed May 16, 1957. 9 claims. Assigned to Paper Converting Machine Co., Inc. [Cl. 164-68.] The machine cuts or perforates a number of spaced parallel transverse lines of weakening in a web of toilet tissue or the like.

Loechl, Clarence J. Gypsum products and process of manufacture. U. S. patent 2,871,134. Filed Nov. 22, 1954. Assigned to Celotex Corp. [Cl. 106-110.] A process is provided for incorporating mineral wool fibers into the furnish used to make gypsum board.

Markey, Frank J. Web guide. U. S. patent 2,871,013. Filed April 3, 1956. 12 claims. Assigned to GPE Controls, Inc. [Cl. 271-2.6.] Machines for processing webs of varying width are provided with means to register the web centerline with the machine.

Martens, Henry F. Poultry package. U. S. patent 2,871,131. Filed Dec. 10, 1954. 4 claims. Assigned to Armour and Co. [Cl. 99-194.] A multi-ply paper bag for packing poultry in ice has orifices permitting the drainage of water from the ice.

Nesslein, Floyd F., and Nesslein, Robert J. Holding device for disposable containers. U. S. patent 2,871,051. Filed Sept. 15, 1955. 5 claims. [Cl. 294-31.] A handled steel device is provided for supporting a gable-top paperboard milk carton during use.

Parfitt, John W. Mold assembly for manufacturing concrete

inlet tops for storm drains. U. S. patent 2,870,515. Filed Sept. 19, 1957. 9 claims. [Cl. 25-118.] A steel-reinforced paperboard mold is used.

Parker, Daniel B., and Kitchen, Harry D. Tear strip, and wrapper and package. U. S. patent 2,870,953. Filed Nov. 7, 1956. 3 claims. Assigned to Kalamazoo Vegetable Parchment Co. [Cl. 229-51.] A novel tear-strip construction is formed in waxed paper wrapped about a carton.

Rapson, William H. Production of chlorine dioxide. U. S. patent 2,871,097. Filed Feb. 6, 1956. 4 claims. Assigned to Hooker Chemical Corp. [Cl. 23-152.]

Ringler, William A. Carton. U. S. patent 2,870,952. Filed Oct. 24, 1955. 2 claims. Assigned to Diamond Gardner Corp. [Cl. 229-44.] An improved hinged lid construction is provided in a box similar to a flip-top cigarette box.

Shelly, Robert S. Multiplex tube construction. U. S. patent 2,871,080. Filed Feb. 3, 1955. 9 claims. Assigned to Pack Mfg. Co. [Cl. 312-107.] A cylindrical paperboard tube within an outer rectangular carton forms a storage container for rolled engineering drawings.

Sherrill, Joseph H. Apparatus for packing and wrapping cigarettes. U. S. patent 2,870,584. Filed May 20, 1955. 14 claims. Assigned to R. J. Reynolds Tobacco Co. [Cl. 53-55.]

Struble, Glenn E. Double walled box. U. S. patent 2,870,-951. Filed Aug. 23, 1955. 5 claims. Assigned to Diamond Gardner Corp. [Cl. 229-34.] An improved corner-locking construction is provided.

Sweeney, Orland R., Arnold, Lionel K., and Long, Justin T. Process of polymerizing a mixture of furfural, a secondary aromatic amine and a lignin compound and product obtained thereby. U. S. patent 2,871,207. Filed Dec. 24, 1953. 11 claims. Assigned to Iowa State College Research Foundation, Inc. [Cl. 260-17.5.]

Weegar, Ralph P., and Unkauf, Henry C. Diazotype reproduction and method. Filed Feb. 21, 1955. 8 claims. Assigned to Eugene Dietzgen Co. [Cl. 96-49.] Cellulose nitrate and ethylcellulose are used in coating an aluminum base for use in a diazotype reproduction method.

Wisner, Isle R., Corbin, Wesley S., and Walden, Henrik. Fourdrinier paper making machines. U. S. patent 2,870,691. Filed May 2, 1955. 5 claims. Assigned to The Black-Clawson Co. [Cl. 92-44.] An improved breast roll mounting and shake mechanism permit greater ease in changing the wire.

Wisner, Isle R., Corbin, Wesley S., and Walden, Henrik. Fourdrinier paper making machine. U. S. patent 2,870,692. Filed May 2, 1955. 2 claims. Assigned to The Black-Clawson Co. [Cl. 92-44.] Various improvements permit wire changing without cantilevering the machine.

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Abernethy, Nelson W., Diss, Edward M., and Sarge, Theodore W. Fiber-forming composition comprising cellulose acetate and acrylonitrile copolymer and fiber consisting essentially of same. U. S. patent 2,872,424. Filed Dec. 16, 1954. 2 claims. Assigned to Dow Chemical Co. [Cl. 260-17.]

Adams, Robert K. Portable insulated container. U. S. patent 2,872,095. Filed Dec. 22, 1954. 3 claims. [Cl. 229-14.] A container is provided for shipping blood plasma or other material which must be transported under constant temperature and humidity conditions.

Andersson, Per Erland D. Holders for a roll of paper. U. S. patent 2,872,263. Filed Jan. 20, 1956. 5 claims. Assigned to Bo Olof Kaller. [Cl. 312–39.] A simple wall-mounted device is provided for supporting and dispensing a roll of paper.

Beckvold, Oscar E., Jr., and Hartman, Paul F. Battery separators. U. S. patent 2,872,497. Filed Oct. 28, 1955. 2 claims. Assigned to United States Rubber Co. [Cl. 136–146.] The separator comprises an alpha-cellulose sheet impregnated with a phenol-formaldehyde resin including a chemically combined permanent wetting agent.

Bull, Harry W., and Finke, Walter A. Lubrication of synthetic cellulose fibers. U. S. patent 2,872,356. Filed June 2, 1955. 3 claims. Assigned to Dow Chemical Co. [Cl. 117–139.5.] The fibers are coated with methylpolysiloxane and used to form threads for use in high-speed sewing machines.

Chaplin, Merle P. Molded pulp set-up box. U. S. patent 2,872,093. Filed Dec. 28, 1956. 7 claims. Assigned to Chaplin Corp. [Cl. 229–2.5.]

Coffin, Harry B. Mailing piece including return envelope forming portion. U. S. patent 2,872,100. Filed Aug. 2, 1954. 6 claims. [Cl. 229–92.1.]

Cosmos, Alexander J. Rotative surfacing tool and tufted packs therefor and method of making such packs. U. S. patent 2,871,632. Filed April 11, 1957. 9 claims. [Cl. 51–193.5.] A pack of abrasive paper is provided for mounting in the peripheral grooves of a rotative abrasive tool.

Dumont, Donald C. Packages for displaying pens, pencils and the like. U. S. patent 2,872,030. Filed March 22, 1957. 2 claims. Assigned to Dennison Co. [Cl. 206–45.14.] The package comprises an open-top carton fitted with a plastic cover which also acts to support the article within the carton.

Eads, David K., and Giusti, Gino P. Production of sulfur from pyrites. U. S. patent 2,872,294. Filed May 16, 1952. 4 claims. Assigned to Texas Gulf Sulphur Co. [Cl. 23–224.] A simplified high-speed fluidized-bed method of roasting is provided.

Forgo, Eric J. Wrapper indexing mechanism for wrapping machines. U. S. patent 2,871,639. Filed Feb. 4, 1957. 16 claims. Assigned to Battle Creek Packaging Machines, Inc. [Cl. 53–180.] A machine for heat sealing articles between two strips of packaging material is provided with means for maintaining proper registry of printed material on the strips.

Forrer, Homer W. Paperboard wrapper having strengthened edges. U. S. patent 2,872,036. Filed Aug. 6, 1956. 3 claims. Assigned to Mead-Atlanta Paper Co. [Cl. 206–65.] A paperboard six-pack can carrier of the open-end sleeve type has strengthened edge portions at the open sleeve ends.

French, Gordon W. Sheet feeding and stacking apparatus. U. S. patent 2,872,190. Filed Sept. 13, 1955. 11 claims. Assigned to Beasley, French & Co. Ltd. [Cl. 271–87.] A machine producing paper bags or envelopes is provided with means for aligning and stacking the products.

Glab, William T. Methods of making a lignocellulose product and the product resulting therefrom. U. S. patent 2,872,330. Filed Sept. 6, 1956. 19 claims. Assigned to Caradco Inc. [Cl. 106–163.] A molding composition is formed of comminuted wood, sulphur, aniline, zinc oxide, and pinewood resin.

Goldstein, Gabriel F. Composition comprising a mixture of synthetic resins and cellulose acetate butyrate for printing on vinyl plastics. U. S. patent 2,872,423. Filed May 6, 1955. 6 claims. Assigned to Interchemical Corp. [Cl. 260–16.]

Goodwin, Fil F. Sheet handling apparatus U. S. patent 2,871,638. Filed July 23, 1953. 43 claims. Assigned to Burroughs Corp. [Cl. 53–32.] The machine provided wraps a stack of paper currency in a wrapper carrying a coating of a self-sealing adhesive.

Grady, Dennis, Bates, Harold, and Fisher, James W. Manufacture of cellulose ester materials. U. S. patent 2,872,331. Filed April 25, 1955. 8 claims. Assigned to British Celanese Ltd. [Cl. 106–178.] A process for melt-spinning unplasticized cellulose triacetate is described.

Granger, Fred L. High density barrier film separators. U. S. patent 2,872,498. Filed April 18, 1955. 5 claims. Assigned to Union Carbide Corp. [Cl. 136–146.] The paper sheet used in this dry-cell separator is a high-density supercalendered sheet formed from a furnish including up to 40% fibrous methylcellulose.

Graybill, Paul J. Reclosable containers. U. S. patent 2,872,097. Filed Aug. 9, 1956. 5 claims. [Cl. 229–44.] A small box similar to a flip-top cigarette box is provided with improved hinged cover-retaining means.

Harkins, Elza E., and Young, Don H. Feed for web press. U. S. patent 2,872,188. Filed Dec. 13, 1956. 1 claim. Assigned to Royal McBee Corp. [Cl. 271–2.2.] Improved web-feeding and tensioning means are provided in a press in which the web is moved only during the periods between impressions.

Heritage, Clark C., and Roberts, James R. Method of coating a felted fibrous mat. U. S. patent 2,872,337. Filed Dec. 30, 1953. 8 claims. Assigned to Weyerhaeuser Timber Co. [Cl. 117–11.] A process is described for making coated hardboard in a single pressing step.

Hjelm, Arvid, and Knutsson-Hall, Folke K. Device for filling matches into boxes. U. S. patent 2,871,637. Filed March 23, 1955. 6 claims. [Cl. 53–26.]

House, Ronald R., and Jen, Yun. Pulping of paper broke containing wet-strength resins. U. S. patent 2,872,313. Filed Sept. 8, 1955. 3 claims. Assigned to American Cyanamid Co. [Cl. 92–1.4.] The broke is slurried with sodium hypochlorite, then pulped mechanically.

Jackson, Jesse A. Paper making machine. U. S. patent 2,871,770. Filed April 17, 1956. 26 claims. [Cl 92–38.] The machine effects air-deposition of high-density stock.

Kessler, Jack J. Deleaver. U. S. patent 2,872,187. Filed Aug. 15, 1955. 5 claims. Assigned to UARCO, Inc. [Cl. 271–2.1.] The apparatus provided separates carbon strips from continuous form stationery after a writing operation.

Kindron, Robert R. Process of bleaching cellulose pulps by absorbing alkali in the pulp and then applying hydrogen peroxide. U. S. patent 2,872,280. Filed May 27, 1953. 1 claim. Assigned to Food Machinery and Chemical Corp. [Cl. 8–104.]

Klingspor, Carl. Grinding bodies. U. S. patent 2,871,633. Filed Sept. 26, 1956. 3 claims. [Cl. 51–207.] Resin-impregnated paper is used in forming the abrasive structure.

Lambert, Harry E. Egg packing flats. U. S. patent 2,872,-062. Filed Sept. 16, 1955. 2 claims. Assigned to Central Fibre Products Co. [Cl. 217–26.5.] The molded pulp flats accommodate eggs of varying size.

Lau, Erwin M. Control for bag filling machine. U. S. patent 2,871,891. Filed May 28, 1954. 11 claims. Assigned to

Black Products Co. [Cl. 141–10.] Improved means are provided to control the feeding of the material being bagged so as to obtain an accurate weight.

Leptien, Elmer E. Anti-skid compositions and container material coated therewith. U. S. patent 2,872,094. Filed Nov. 9, 1956. 7 claims. Assigned to St. Regis Paper Co. [Cl. 229–3.5.] The compositions are applicable to paper bags or cartons.

Lindberg, Paul W. Display carton construction. U. S. patent 2,872,031. Filed June 22, 1956. 1 claim. [Cl. 206–45.34.] A tamperproof display carton for toys comprises a flat open-end paperboard sleeve with plastic end closures.

Mayer, Fred H. Volatile fumigant pad. U. S. patent 2,872,244. Filed June 26, 1956. 4 claims. [Cl. 299–24.] The deodorizing or other fumigant material is carried in a coating on a paperboard support.

Mercer, Lewis P. Art of producing side-gusseted bags. U. S. patent 2,871,771. Filed June 12, 1952. 2 claims. Assigned to Milprint, Inc. [Cl. 93–35.]

Nehring, Frederick L. Paper dispensers. U. S. patent 2,872,264. Filed April 25, 1956. 8 claims. [Cl. 312–39.] A wall-mounted dispenser is provided for holding and successively dispensing several rolls of paper.

Nelson, John E. Machine and method for spot treating foldable sheets. U. S. patent 2,871,772. Filed Oct. 3, 1955. 1 claim. Assigned to International Paper Box Machine Co. [Cl. 93–36.] Adhesive is applied or removed from certain areas of box blanks as the blanks are traveling, without requiring the exact registration of the blanks.

Newman, Douglas A., and Schlotzhauer, Allan T. Transfer element and method of making the same. U. S. patent 2,872,-340. Filed Feb. 18, 1954. 9 claims. Assigned to Columbia Ribbon & Carbon Mfg. Co. [Cl. 117–36.] Ethylcellulose is included in a coating composition used in preparing carbon paper.

Pawelka, Gustav J. Display sign. U. S. patent 2,871,598. Filed Oct. 1, 1957. 5 claims. Assigned to Fairhaven Properties Corp. [Cl. 40–130.] A display sign set up from a paperboard blank is designed to simulate the effect of a brightly illuminated sign.

Prevost, Burno E. Jordan plug body. U. S. patent 2,871,769. Filed March 18, 1955. 12 claims. Assigned to John W. Bolton & Sons, Inc. [Cl. 92–27.] Reinforcement of the shell is provided.

Prial, Gerald. Envelopes. U. S. patent 2,872,099. Filed Aug. 3, 1955. 1 claim. [Cl. 229–73.] A one-piece send-and-return envelope is designed for complete sealing in the return form.

Raybuck, William B. Folder for printing presses. U. S. patent 2,872,186. Filed July 10, 1956. 9 claims. Assigned to Fred'k H. Levey Co., Inc. [Cl. 270–69.]

Robinson, Thomas R. Tray loading mechanisms for transferring a sheet unit to a receiving surface. U. S. patent 2,872,-189. Filed Dec. 10, 1956. 8 claims. [Cl. 271-54.] Charging means are provided for a multiple-opening hardboard hot press.

Rolle, Clifford J., Roteman, Jerome, and Barnes, William D., Jr. Ice releasing coating composition comprising nitrocellulose, oil modified alkyd, vinyl polymer, wax, and organic solvent. U. S. patent 2,872,422. Filed June 22, 1954. 9 claims. Assigned to Interchemical Corp. [Cl. 260–16.]

Samuelson, Hans O. Process in recovering sulphur from waste sulphite lye. U. S. patent 2,872,289. Filed May 10, 1955 3 claims. Assigned to AB. Rosenblads Patenter. [Cl. 23–129.]

Sandberg, Nels H. Method of making pulp. U. S. patent 2.872,314. Filed July 12, 1954. 7 claims. Assigned to Waldorf Paper Products Co. [Cl. 92–6.] A continuous method of cooking wood chips includes preimpregnation, cooking, and defibration stages.

Sauerman, Ernst C. Combination envelope. U. S. patent 2,872,098. Filed Oct. 20, 1955. 1 claim. Assigned to Gaw-O'Hara Envelope Co. [Cl. 229–72.] The two compartments of the envelope are designed to hold materials of different post office classification.

Schroeder, Carl W. Polyepoxide emulsions and method of treating textiles therewith. U. S. patent 2,872,427. Filed Oct. 4, 1954. 20 claims. Assigned to Shell Development Co. [Cl. 260–29.2.] The emulsions may be used for imparting wet-strength to paper.

Schwartz, Harold A. Twisted paper yarn. U. S. patent 2,871,652. Filed March 26, 1956. 2 claims. Assigned to Patchogue-Plymouth Corp. [Cl. 57-167.]

Scripture, Edward W., Jr., and Benedict, Stephen W. Hydraulic cement compositions. U. S. patent 2,872,329. Filed Dec. 14, 1954. 7 claims. Assigned to American-Marietta Co. [Cl. 106–92.] Spent sulphite liquor derivatives are used.

Shelly, Robert S. Multiple unit storage file. U. S. patent 2,872,265. Filed May 4, 1956. 20 claims. Assigned to Pack Mfg. Co. [Cl. 312–107.] A storage container for rolled engineering drawings comprises a cylindrical paper tube within an outer paperboard container of square cross section.

Shelton, Frederic J., and Chervenka, Charles H. Plywood adhesive comprising urea formaldehyde resin protein and dispersing agent and process for preparing same. U.S. patent 2,872,421. Filed May 29, 1956. 11 claims. Assigned to Reichhold Chemicals, Inc. [Cl. 260–6.]

Tobey, Leon H. Device for opening carton closure flaps. U. S. patent 2,871,641. Filed Dec. 18, 1957. 3 claims. Assigned to Bloomer Bros. Co. [Cl. 53–382.] The device provided opens the closure flaps of an ice cream carton while the carton is being filled.

Tostado, Javier A. Mechanism for sealing bags. U. S. patent 2,872,061. Filed July 2, 1956. 1 claim. [Cl. 216–29.] The machine tapes the gathered neck of a bag presented manually to the taping mechanism.

Truini, Richard C. Means for opening carton folding closure flaps. U. S. patent 2,871,640. Filed Dec. 18, 1957. 3 claims. Assigned to Bloomer Bros. Co. [Cl. 53–382.]

Vines, Oscar L. Collapsible cellular carton. U. S. patent 2,872,096. Filed April 7, 1954. 2 claims. Assigned to Alfords Cartons. [Cl. 229–28.] An egg carton is improved in strength by proper orientation of the grain of the paperboard panels.

Warnow, Morton C. Holders for photographic negatives and prints. U. S. patent 2,871,601. Filed July 7, 1958. 3 claims. [Cl. 40–158.] A device formed from waxed paper and paper carrying a coating of pressure-sensitive adhesive is used as a file or mount for photos and negatives.

Watkins, Spencer H. Sizing paper and product. U. S. patent 2,872,315. Filed Sept. 14, 1956. 6 claims. Assigned to Hercules Powder Co. [Cl. 92–21.] A rosin acid dimer is used to improve the efficiency of the beater sizing of pulp with tall oil rosin sizes.

Weiss, Thomas B. Air leaflet. U. S. patent 2,871,596. Filed Nov. 16, 1953. 7 claims. [Cl. 40–127.]

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Barrett, Edward J., Jr., and Flitter, David. Alkyd resin composition and metals coated therewith. U. S. patent 2,873,-210. Filed Jan. 17, 1957. 13 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117–75.] A tall oil derivative is used.

Brennen, Joseph B. Metal-coated batt and method and apparatus for producing same. U. S. patent 2,873,219. Filed Dec. 20, 1954. 8 claims. [Cl. 117–227.] A method is provided of incorporating metal into a batt of cotton fibers which is later coiled with paper strips in the manufacture of condensers.

Clem, Everett W. Spiral wrapping machine. U. S. patent 2,872,767. Filed Dec. 1, 1954. 5 claims. Assigned to Rice Barton Corp. [Cl. 53–198.] The machine applies a spiral wrapping of paper to large heavy rolls of paper as formed at the paper mill.

Corwin, John F. Urea-formaldehyde gap-filling adhesive U. S. patent 2,873,260. Filed June 16, 1955. 5 claims. Assigned to Koppers Co., Inc. [Cl. 260–17.3.] Wood flour and other cellulosic materials are used as fillers.

Crafts, Curtis S., and McWhorter, Henry L. Apparatus for producing magazines and the like. U. S. patent 2,873,112. Filed June 29, 1955. 7 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 270–12.] This is similar to U. S. patent 2,873,113 (Feb. 10, 1959).

Crosfield, John F., and Gold, Daniel. Register control of moving webs. U. S. patent 2,873,117. Filed March 30, 1956. 17 claims. Assigned to J. F. Crosfield Ltd. [Cl. 271–2.6.]

Dusenbury, Theodore P., and Warren, Charles G. Check shingling attachment for a printing press. U. S. patent 2,873,-115. Filed April 4, 1955. 3 claims. Assigned to Burroughs Corp. [Cl. 270–58.]

Erickson, Karl H. Transparent display container. U. S. patent 2,873,023. Filed Dec. 22, 1955. 3 claims. Assigned to Amerock Corp. [Cl. 206–45.34.] The container comprises a drawn plastic dome and a flanged-edge paperboard bottom-forming member.

Fahrenkrug, Willard J. Machine and method for erecting a carton and integral cover on one operation. U. S. patent 2,872,855. Filed Aug. 10, 1953. 14 claims. Assigned to Badger Paper Mills, Inc. [Cl. 93–51.]

Fitzpatrick, William B. Method and apparatus for edge forming sheet material. U. S. patent 2,872,981. Filed Dec. 31, 1956. 3 claims. Assigned to Harrison-Simpson Co. [Cl. 164-61.] The apparatus decoratively cuts the edges of folded greeting card and stationery blanks.

Friday, Paul D. Container with cover lock. U. S. patent 2,873,057. Filed March 29, 1955. 7 claims. Assigned to Paper Maid, Inc. [Cl. 229–2.5.] A molded pulp hinged-lid egg carton is provided with integral cover-locking means.

Hanford, Carlton M. Coated abrasive article and method of making. U. S. patent 2,873,181. Filed Sept. 1, 1954. 10

claims. Assigned to Carborundum Co. [Cl. 51–298.] In making abrasive paper, improved bonding of the abrasive coating is achieved by using wollastonite as filler in the adhesive.

Hopkins, William C., and Senese, John G., Jr. Liquid rosin sizes containing anti-stratifying agent. U. S. patent 2,873,203. Filed Feb. 25, 1954. 5 claims. Assigned to American Cyanamid Co. [Cl. 106–238.]

Inman, Daniel O. Receptacle liner. U. S. patent 2,873,060. Filed April 18, 1955. 1 claim. [Cl. 229–31.] A blank of waxed paper sets up to form a lunch box liner.

Janson, Harry. One piece hinged case. U. S. patent 2,873,058. Filed Aug. 28, 1957. 8 claims. [Cl. 229–27.] A flat hinged-lid cigarette box is designed to prevent relative movement of the cigarettes remaining after some of them have been removed.

Jones, Frank O., Jr. Non-clay-reactive drilling fluid. U. S. patent 2,873,251. Filed Sept. 19, 1956. 18 claims. Assigned to Pan American Petroleum Corp. [Cl. 252–5.] Carboxymethylcellulose is used.

Koester, Melvin C. Shipping container for glass sheets. U. S. patent 2,873,024. Filed Jan. 2, 1957. 12 claims. Assigned to Libbey-Owens-Ford Glass Co. [Cl. 206-62.]

Lambert, Donald R. Paper-feeding mechanism. U. S. patent 2,873,116. Filed Oct. 30, 1957. 22 claims. Assigned to Powers-Samas Accounting Machines Ltd. [Cl. 271–2.4.] A variable-speed paper feeding device is provided for machines for effecting intermittent imprinting on the paper by means of styluses.

McWhorter, Henry L. Apparatus for producing magazines and the like. U. S. patent 2,873,113. Filed June 29, 1955. 8 claims. Assigned to Miehle-Goss-Dexter, Inc. [270–12.] The machine cuts, folds, assembles, and binds several preprinted paper webs.

Manas, Herman D. Label applying means. U. S. patent 2,873,040. Filed April 5, 1957. 4 claims. Assigned to M. R. M. Machinery Co., Inc. [Cl. 216–55.] Supplementary glue applying means are provided in a machine for labeling containers.

Michlein, Carl P. Apparatus for measuring quantities of small articles and packaging same. U. S. patent 2,872,765. Filed Jan. 12, 1955. 15 claims. Assigned to Shelton Tack Co. [Cl. 53–64.] The apparatus fills small containers of various types with measured weights of small nails, etc.

Reifers, Richard F. Egg carton. U. S. patent 2,873,059. Filed March 26, 1957. 13 claims. Assigned to Diamond Gardner Corp. [Cl. 229–28.] The folding carton collapses to present a perfectly rectangular periphery.

Rollie, Robert D. Packaging device. U. S. patent 2,873,025 Filed Jan. 23, 1956. 8 claims. Assigned to Minnesota Mining & Mfg. Co. [Cl. 206-65.] An open-end paperboard carton is provided for the bulk packaging of a number of rolls of adhesive tape.

Schwartz, Herbert. Method for inhibiting the formation and growth of slime in water systems. U. S. patent 2,873,249. Filed Sept. 23, 1957. 6 claims. [Cl. 210–64.] Slime in paper mill water systems is inhibited by addition of bis-1,4-bromacetoxy-2-butene.

Sisson, James B. Methods and apparatus for forming sandwiches of a foamed plastic layer interposed between webs of sheet material. U. S. patent 2,872,965. Filed Sept. 15, 1954. 3 claims. Assigned to St. Regis Paper Co. [Cl. 154–1.] The laminated structure produced comprises a foamed polystyrene core between paper facing sheets.

Weegar, Ralph P., and Unkauf, Henry C. Diazotype reproduction material and method. U. S. patent 2,873,207. Filed Feb. 21, 1955. 12 claims. Assigned to Eugene Dietzgen Co. [Cl. 117–34.] Various cellulose esters and ethers are employed in coating the cloth base used.

Wolfram, George, and Manteuffel, Allan. Extreme pressure lubricants. U. S. patent 2,873,254. Filed Aug. 1, 1952. 8 claims. Assigned to Pure Oil Co. [Cl. 252–46.6.] A sulphurized methyl ester of tall oil acids is included in a lubricating composition for automobiles.

Zintel, Clarence C. Coat-hanger cover. U. S. patent 2,873,054. Filed Dec. 27, 1955. 6 claims. [Cl. 223–98.] The paper cover assists in the support of the garment.

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Abramson, Harvey J. Multiple-hanging-garment shipping container. U. S. patent 2,873,851. Filed June 3, 1957. 3 claims. Assigned to Sears, Roebuck and Co. [Cl. 206–7.]

Arneson, Lawrence E. Method and apparatus for packaging cans and the like. U. S. patent 2,873,565. Filed Jan. 3, 1955. 6 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 53–29.] The machine sets up and loads six-pack paperboard can carriers.

Bergman, Arthur. Wood rechipper. U. S. patent 2,873,923. Filed July 16, 1956. 1 claim. Assigned to Columbia Veneer Co. (Cl. 241–280.] Oversize chips produced by a conventional pulpwood chipper are reduced in dimension by the apparatus provided.

Blair, Boyd C. Method of packaging boards and package thereof. U. S. patent 2,873,852. Filed April 29, 1957. 2 claims. Assigned to Brackett Stripping Machine Co. [Cl. 206–60.] A stack of paper-faced gypsum boards are marginally glued to form a shipping unit.

Brown, Lloyd H. Resinification of furfuryl alcohol and formaldehyde at high hydrogen-ion concentrations. U. S. patent 2,874,148. Filed July 29, 1954. 3 claims. Assigned to The Quaker Oats Co. [Cl. 260–67.]

Collin, Herbert S. Shield for clothes hangers. U. S. patent 2,873,899. Filed Nov. 25, 1955. 3 claims. [Cl. 223–98.]

Denton, Harvey R. Bag and header therefor including bag supporting means. U. S. patent 2,873,905. Filed Oct. 3, 1955. 5 claims. [Cl. 229–55.]

Deverell-Smith, Raymond, Mitchell, John, and Twitchett, Harry J. Polymeric compositions. U. S. patent 2,874,146. Filed June 26, 1956. 8 claims. Assigned to Imperial Chemical Industries Ltd. [Cl. 260–45.85.] Various monoazo compounds are included in cellulose ester compositions to improve light resistance.

Eckles, William J. Dispensing apparatus. U. S. patent 2,873,894. Filed July 5, 1957. 3 claims. Assigned to Morton Salt Co. [Cl. 222–480.] A metallic combination pouring spout-sifter unit is provided for affixing in the top panel of a container for granular materials.

Florence, Robert T. Copy process and materials for use in same. U. S. patent 2,873,671. Filed May 11, 1955. 15 claims. Assigned to A. B. Dick Co. [Cl. 101–149.4.] A diazotype duplicating process and materials are described.

Griffin, William K., Jr., and Killion, John F. Apparatus for applying adhesive to predetermined areas of a series of articles. U. S. patent 2,873,717. Filed July 7, 1953. 12 claims. Assigned to Food Machinery and Chemical Corp. [Cl. 118–204.] The machine applies a pattern of adhesive to the end closure flaps of cartons.

Grobman, William. Hydraulically loaded feed rolls for corrugated paper stock. U. S. patent 2,873,968. Filed April 8, 1957. 4 claims. Assigned to Samuel M. Langston Co. [Cl. 271–51.] Corrugated board blanks are fed to printer-slotters or the like without crushing.

Johnson, Al, and Gauger, Fred W. Carton locking mechanism. U. S. patent 2,873,655. Filed Dec. 13, 1956. 6 claims. Assigned to Valley Pattern & Mfg. Co. [Cl. 93–51.] The machine sets up corner-locking cartons so that the locking flaps within the carton lie flat against the side wall of the carton.

Johnson, Carl E. 1,2-Substituted imidazolinium salt and treatment of cellulosic fibrous materials therewith. U. S. patent 2,874,074. Filed May 8, 1956. 21 claims. Assigned to National Aluminate Corp. [Cl. 117–139.5] The softness and water repellency of paper and textiles are increased.

Klimkowski, Robert J., and Florence, Robert T. Azo dye duplicating process. U. S. patent 2,873,668. Filed April 13, 1953. 10 claims. Assigned to A. B. Dick Co. [Cl. 101–149.4] A diazotype duplicating process is described.

Lambert, Robert D. Actuating mechanism for collating machine. U. S. patent 2,873,966. Filed Sept. 27, 1956. 9 claims. Assigned to Halvorsen Products Mfg. Co. [Cl. 270–58.] The mechanism controls and coordinates the various feeding devices involved.

Larson, Richard L. Tab-forming tape dispenser. U. S. patent 2,873,967. Filed May 3, 1956. 5 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl 270–68.] A tape dispenser doubles back the leading end of the tape upon itself to form a grasping tab.

Lockman, Carl J. Methods for extracting heat and SO_2 from sulphite waste lye containing SO_2. U. S. patent 2,874,043. Filed Feb. 18, 1953. 4 claims. Assigned to Aktiebolaget Rosenblads Patenter. [Cl. 92–2.]

Loetscher, Martin B. Combined letter and envelope with juxtaposed pair of three-ply folded corners. U. S. patent 2,873,906. Filed April 16, 1957. 1 claim. [Cl. 229–92.1.]

Loetscher, Martin B. Combined letter and envelope with juxtaposed pair of two-ply folded corners. U. S. patent 2,873,907. Filed April 16, 1957. 1 claim. [Cl. 229–92.1.]

MacCallum, James A. Machines for manufacture of egg cartons. U. S. patent 2,873,654. Filed March 2, 1956. 12 claims. Assigned to Gummed Tapes (Proprietary) Ltd. [Cl. 93–37.]

McLaughlin, Paul J., and Toy, Walter W. Coated paper products and methods for making them. U. S. patent 2,874,066. Filed Oct. 17, 1955. 17 claims. Assigned to Rohm & Haas Co. [Cl. 117–65.]

Mayer-Krapoll, Hermann. Process of improving forest soil and arboreal growth. U. S. patent 2,874,035. Filed Jan. 14, 1955. 5 claims. Assigned to Ruhr-Stickstoff A.-G. [Cl. 71–1.] A compound yielding ammonia-nitrogen is introduced is introduced into the crude humus top soil layer of the forest leaf mold surface mulch.

Ohlinger, Leo A., and Young, Gale J. Test-hole construction for a neutronic reactor. U. S. patent 2,874,108. Field May 8, 1946. 2 claims. Assigned to the United States Atomic Energy Commission. [Cl. 204–193.2.] Masonite is used in the construction.

Petrenko, Alexander M. Method of waterproofing paper, cloth or fur and products produced thereby. U. S. patent 2,874,075. Filed Oct. 3, 1956. 8 claims. Assigned to Petren Products Inc. [Cl. 117–140.] Solutions of alum and lead acetate are mixed, the precipitate separated, and the substrate treated with the clear solution obtained.

Santos, John R. L. Dryer felt connection. U. S. patent 2,873,494. Filed June 24, 1954. 5 claims. Assigned to William E. Hooper and Sons Co. [Cl. 24–33.]

Schubert, Bernhard. Conveying and gluing apparatus for filter cigarette tip wrappers. U. S. patent 2,873,719. Filed March 7, 1956. 8 claims. Assigned to Kurt Korber & Co. K.-G. [Cl. 118–247.]

Stubblefield, James L. Device for dividing a single line of cartons into two lines. U. S. patent 2,873,836. Filed April 19, 1956. 5 claims. [Cl. 193–36.]

Warner, Roger M. Apparatus for measuring equilibrium humidity of paper. U. S. patent 2,873,605. Filed July 15, 1954. 2 claims. Assigned to Champion Paper and Fibre Co. [Cl. 73–73.]

Wenzl, Hermann F. J. Multistage process relating to the alkaline digestion of raw cellulosic materials for the production of pulp with a high content of alpha cellulose. U. S. patent 2,874,044. Filed Dec. 23, 1955. 2 claims. [Cl. 92–13.]

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Adams, Dennis A. W., and Sarkar, Asim K. Optical whitening agents. U. S. patent 2,875,106. Filed March 15, 1957. 16 claims. Assigned to Hickson & Welch Ltd. [Cl. 117–335.] These brighteners are for use on paper or textiles.

Baer, Byron N., Brandner, John D., and Le Maistre, John W. Spinning of viscose. U. S. patent 2,875,078. Filed Aug. 22, 1955. 7 claims. Assigned to Atlas Powder Co. [Cl. 106–165.] High-tenacity rayon fibers are formed from a viscose to which has been added certain aminopropyl oxyethylene alcohol ethers.

Ball, Fred M., and Coney, Charles H. Sulfonic acid catalyzed cellulose acetate butyrate urea-formaldehyde coating composition for paper and process of preparation. U. S. patent 2,875,164. Filed Feb. 6, 1957. 2 claims. Assigned to Eastman Kodak Co. [Cl. 260–15.]

Bloem, Herman, and Stel, Marinus. Method of impregnating fibre masses with a viscous hardenable resin insoluble in water. U. S. patent 2,875,094. Filed Nov. 16, 1953. 7 claims. Assigned to North American Philips Co., Inc. [Cl. 117–115.] A method is described for preparing a phenol-formaldehyde resin-impregnated paper of use in forming dielectric laminates.

Browne, Donald B., and Buckman, Kenneth E. Filter for filtration of fluids. U. S. patent 2,874,849. Filed Aug. 24, 1955. 3 claims. Assigned to General Motors Corp. [Cl. 210–347.] A stack of disks of resin-impregnated paper is used in forming an oil filter element.

Clark, Robert E. Spinning solution. U. S. patent 2,875,079. Filed March 4, 1957. 6 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 106–165.] A soluble sulphite and a soluble salt of a sulphated fatty acid are added to viscose to improve the luster of rayon filaments spun therefrom.

Collura, Peter C. Handle carton. U. S. patent 2,874,870. Filed April 26, 1957. 5 claims. Assigned to Container Corp. of America. [Cl. 220–112.] An open-end six-pack can carrier is provided with a multi-ply extensible handle element.

Cravits, Phillip. Wrapping machine. U. S. patent 2,874,-527. Filed Dec. 24, 1951. 11 claims. [Cl. 53–378.] Various simplifications are provided in a machine for sealing a box within a cellophane overwrap.

Dunn, Lewis R., and Eckert, Lewis W. Fiberboard and method of flameproofing the same. U. S. patent 2,875,044. Filed May 31, 1957. 12 claims. Assigned to Armstrong Cork Co. [Cl. 92–3.] Boric acid is applied to the board web, the web is heat-dried, and a separate flame-resistant coating is applied to the board.

Eckert, Lewis W. Method of drying water-laid fibrous materials. U. S. patent 2,874,617. Filed June 30, 1955. 13 Claims. Assigned to Armstrong Cork Co. [Cl. 92–40.] Discoloration during heat-drying is prevented by applying boric acid to the web prior to drying.

Eckert, Lewis W. Method of fabricating a sound-absorbing unit from cellulosic material. U. S. patent 2,874,796. Filed May 2, 1955. 7 claims. Assigned to Armstrong Cork Co. [Cl. 181–33.] An improved method is provided for forming fissures in the surface of acoustical board.

Ehrlich, Joseph R. Rubber coated wood. U. S. patent 2,875,101. Filed July 29, 1954. 3 claims. [Cl. 117–148.] Methylcellulose is used in a wood-coating composition.

Evanstein, Milton C. Box. U. S. patent 2,874,890. Filed Aug. 9, 1956. 1 claim. [Cl. 229–34.] Adhesive tape is applied to the box blank to facilitate securing the box in its subsequently erected form.

Flanagan, Thomas E. Paper rolls and method of making. U. S. patent 2,874,831. Filed May 20, 1954. 8 claims. Assigned to Kalamazoo Vegetable Parchment Co. [Cl. 206–59.] The ends of a wound roll of waxed paper are covered with a sealing coat of wax.

Gerhard, James R., II. Suspension polymerization using sorbitol, methyl cellulose and gelatin. U. S. patent 2,875,187. Filed Feb. 1, 1957. 3 claims. Assigned to Firestone Tire & Rubber Co. [Cl. 260–92.8] This is similar to U. S. patent 2,875,186 (Feb. 24, 1959).

Gerhard James R., II, Deegan, Claude C., and Fisher, Thomas W., Jr. Process for polymerizing vinyl chloride in the presence of methyl cellulose gelatin and inert solvent. U. S. patent 2,875,-186. Filed Dec. 9, 1954. 2 claims. Assigned to Firestone Tire & Rubber Co. [Cl. 260–92.8] Methylcellulose is employed in a suspension polymerization process for vinyl chloride.

Gilbert, Joseph A., Johnson, Reginald F., and Rose, Alfred G. Method of manufacturing wrapped packages of edible plastic material. U. S. patent 2,875,069. Filed May 5, 1955. 7 claims. Assigned to Rose Bros. (Gainsborough Ltd.). [Cl. 99–171.] Blocks of ice cream, each provided with a handle stick, are wrapped paper.

Gottscho, Ira S., and Hirschey, Malcolm. Transfer labeling apparatus. U. S. patent 2,874,499. Filed April 11, 1956. 24 claims. Assigned to Dennison Mfg. Co. [Cl. 41–1.] The machine effects the heat-transfer of a label from a paper backed strip of label material to a carton or other article.

Griggs, William H., and Butler, Frank A. Photographic paper having reduced processing curl. U. S. patent 2,875,055. Filed Oct. 18, 1956. 3 claims. Assigned to Eastman Kodak Co. [Cl. 96–85.]

Griggs, William H., and Curme, Henry G. Preparation of coatings of improved internal strength. U. S. patent 2,875,054. Filed May 24, 1956. 7 claims. Assigned to Eastman Kodak Co. [Cl. 96–85.] A method is described for improving the internal coating strength of baryta photo paper overcoated with a light-sensitive silver halide emulsion.

Hale, William F. Carton for packing fruits, vegetables or the like. U. S. patent 2,874,889. Filed Aug. 22, 1955. 2 claims. Assigned to Paperbox Corp. [Cl. 229–23.]

Hennessey, Russell J. Can carrying carton. U. S. patent 2,874,869. Filed Feb. 21, 1956. 6 claims. Assigned to Waldorf Paper Products Co. [Cl. 220–112.] In a six-pack can carrier, the end of the cans in one row abut the ends of the cans in the other row.

Heritage, Clark C. Separating pure sclerenchyma fibers from Douglas fir bark. U. S. patent 2,874,908. Filed Sept. 29, 1953. 3 claims. Assigned to Weyerhaeuser Timber Co. [Cl. 241–24.]

Hornbostel, Lloyd. Apparatus for coating. U. S. patent 2,874,674. Filed Jan. 28, 1957. 8 claims. Assigned to Beloit Iron Works. [Cl. 118–113.] Improved doctor roll mounting is provided in a paper coater.

Horning, Raymond H., and Wilcox, Isaac L. Liquid tight container with fibrous side wall. U. S. patent 2,874,888. Filed March 14, 1957. 2 claims. Assigned to Sealright-Oswego Falls Corp. [Cl. 229–5.6.] Improved means are provided for joining the metal bottom to the cylindrical side wall of an ice cream container.

Howard, Alfred H. Mailing piece or advertising sheet provided with an interlocking return envelope. U. S. patent 2,874,892. Filed April 16, 1956. 2 claims. Assigned to Fairbanks Ward Industries, Inc. [Cl. 229–73.]

Kahler, Maurice C. Self-lighting cigarette. U. S. patent 2,874,700. Filed April 20, 1956. 4 claims. [Cl. 131–7.] An inflammable sleeve is affixed to one end of a cigarette, a match is attached to the sleeve, and the cigarette package is provided with an ignition surface.

Kaveler, Herman H. Hydraulic cements having an extended thickening time and processes employing the same. U. S. patent 2,874,778. Filed Aug. 14. 1952. 12 claims. Assigned to Phillips Petroleum Co. [Cl. 166–31.] Sodium carboxymethylcellulose is used.

Kelly, Jack R. Apparatus for guiding traveling webs. U. S. patent 2,874,961. Filed Nov. 8, 1956. 24 claims. Assigned to The Pusey & Jones Corp. [Cl. 271–2.6.) The improved guide roll may be used in relation to paper webs or a paper machine felt or wire.

Kelsall, Jack R. Container and method of making same U.S. patent 2,874,891. Filed Aug. 24, 1956. 5 claims. Assigned to Growers Container Corp. [Cl. 229–37.] Box blanks carrying preapplied pressure-sensitive adhesive are designed so the collapsed boxes may be stacked without adherence between adjacent blanks.

Kerwin, Joseph E. Electrical contact board game. U. S. patent 2,874,966. Filed Aug. 11, 1953. 7 claims. [Cl. 273–

93.] A multi-ply structure of paper and metal foil is used in constructiing the game board.

Knowles, William L. Process of bending wood. U. S. patent 2,874,753. Filed April 24, 1956. 2 claims. [Cl. 154–33.05.] The process produces a corrugated paper-wood laminate.

Layden, Paul W. Sheet feeding system for printing presses and the like. U. S. patent 2,874,962. Filed Nov. 16, 1953. 6 claims. [Cl. 271–27.]

Lewis, Allen H. Non-caking solid particulate detergents. U. S. patent 2,875,154. Filed Aug. 1, 1952. 4 claims. Assigned to California Research Corp. [Cl. 252–138.] Sodium carboxymethylcellulose is used.

Lima, Harald. Packing of plates and like by means of a slip of pasteboard or other material. U. S. patent 2,874,521. Filed Sept. 12, 1955. 2 claims. [Cl. 53-3.]

Löfgren, Bror, and Ogland, Nils J. Method of treating fibre boards. U. S. patent 2,874,481. Filed June 28, 1954. 6 claims. Assigned to Aktiebolaget Svenska Flaktfabriken. [Cl. 34–16.] A postdrying moistening treatment improves the moisture resistance and surface smoothness of hardboard and the like.

Lurie, David. Alum containing antioxidant and manufacture of sized paper therewith. U. S. patent 2,875,045. Filed April 28, 1955. 10 claims. Assigned to American Cyanamid Co. [Cl. 92-21.]

McEwen, Robert L., Raleigh, Charles W., and Price, Carl E. Method of simultaneously bleaching and coating paper. U. S. patent 2,875,102. Filed March 17, 1955. 5 claims. Assigned to Food Machinery and Chemical Corp. [Cl. 117–152.] A reducing agent such as zinc hydrosulphite is included in a conventional paper coating composition.

McLellan, Kenneth M. Composition for and method of pigmenting viscose. U. S. patent 2,875,077. Filed April 2, 1954. 4 claims. Assigned to Industrial Rayon Corp. [Cl. 106–165.]

Marron, Thomas U., White, Fred K., Jr., and Rosenberger, Helen M. Positive working photolithographic plate and method for manufacturing same. U. S. patent 2,875,046. Filed March 1, 1954. 5 claims. Assigned to A. B. Dick Co. [C.. 96–33.] Tissue paper or glassine is used in combination with an aluminum sheet in forming the plate.

Morris, George V. Code card device. U. S. patent 2,874,977. Filed Feb. 14, 1957. 1 claim. Assigned to Zenith Radio Corp. [Cl. 283–6.] Coded information used in operating a subscription TV system is distributed by means of a multi-ply paper-plastic-foil device.

Müller, Hans. Trimming machine for automatically trimming the three open edges of stapled booklets. U. S. patent 2,874,775. Filed May 6, 1957. 3 claims. [Cl. 164–48.]

Pallmann, Ludwig. Process and device for producing flat wood shavings. U. S. patent 2,874,909. Filed Oct. 14, 1953. 5 claims. [Cl. 241–28.]

Phin, Sydney R. Apparatus for heat sealing cartons. U. S. patent 2,874,619. Filed Dec. 15, 1955. 2 claims. [Cl. 93–44.]

Ring, Robert G. Wood preservation method and package. U. S. patent 2,875,020. Filed Nov. 5, 1956. 6 claims. Assigned to Chapman Chemical Co. [Cl. 21–7.] Paper coated with penthachlorophenol is used in a wrapping for wood in contact with soil.

Ringler, William A. Package and method of forming the same. U. S. patent 2,874,524. Filed Nov. 7, 1955. 4 claims. Assigned to Diamond Gardner Corp. [Cl. 53–29.] Several flip-top cigarette boxes are described.

Rockland, Louis B., and Atkinson, Lawrence F. Method and apparatus for packaging powders and the like. U. S. patent 2,875,070. Filed Oct. 24, 1955. 10 claims. Assigned to U. S. Secretary of Agriculture, [Cl. 99–171.] Powders are vacuum-sealed within small bags without loss of the powder during the vacuumizing.

Roehrig, Jonathan R. Discriminating plural counter assembly of fibers. U. S. patent 2,874,899. Filed March 7, 1955. 3 claims. Assigned to National Research Corp. [Cl. 235–92.] A photoelectric apparatus determines the average diameter and diameter distribution of fibers.

Stafford, Neil S. Valve for fluids or fluidized solids especially for the spouts of bag filling apparatus. U. S. patent 2,874,925. Filed Sept. 17, 1954. 6 claims. Assigned to Food Machinery and Chemical Corp. [Cl. 251–61.]

Tench, John D. Pour depressed microcrystalline wax. U. S. patent 2,875,082. Filed July 18, 1955. 7 claims. Assigned to Sun Oil Co. [Cl. 106–270.] The modified wax compositions form smooth-surfaced coatings.

Toensmeier, Patrick A. Can carrier. U. S. patent 2,874,833. Filed Jan. 30, 1956. 10 claims. Assigned to The New Haven Board & Carton Co. [Cl. 206–65.]

Twining, Ralph H. Gels and process for making them. U. S. patent 2,874,545. Filed March 2, 1954. 18 claims. Assigned to L. H. Lincoln & Son, Inc. [Cl. 61–36.] Spent sulphite liquor is used in making a composition of use in well-drilling.

Wertepny, Alexander W., Jr. Sealable re-usable skin packed packages for merchandise articles and method of forming same. U. S. patent 2,874,836. Filed March 11, 1957. 1 claim. [Cl. 206-78.] A blister-pack for hardware items is described.

Woodward, William W. Multiple article packages. U. S. patent 2,874,834. Filed May 17, 1957. 1 claim. Assigned to Alton Box Board Co. [Cl. 206-65.] A series of superposed paperboard trays are used to unitize a number of smaller packages.

Yang, Christen H. C. Creped paper with improved softness and process of making the same. U. S. patent 2,874,618. Filed Feb. 7, 1955. 4 claims. Assigned to Crown Zellerbach Corp. [Cl. 92-70.] The creped web is passed through the nip of rollers one of which has grooves which contact the web at an angle to the direction of creping.

Yost, De Witte M., and Schmitt, James C. Pleating paper and method. U. S. patent 2,874,754. Filed Aug. 6, 1956. 12 claims. Assigned to The Sorg Paper Co. [Cl. 154-33.05.] Paper for use in pleating fabrics is provided with a coating of a self-adhering adhesive on the side of the paper not in contact with the fabric.

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Anness, Russell W. Blank gluing apparatus. U. S. patent 2,875,726. Filed Jan. 25, 1956. 10 claims. Assigned to Diamond Gardner Corp. [Cl. 118-212.] The apparatus registers box blanks then applies a shaped adhesive pattern to a specified area of each blank.

Baer, Byron N., Brandner, John D., and Le Maistre, John W. Spinning of viscose. U. S. patent 2,876,124. Filed Aug. 22, 1955. 7 claims. Assigned to Atlas Powder Co. [Cl. 106-165.] Smooth-surfaced high tenacity filaments are obtained by adding to the viscose a polyethylene glycol ether of an amino phenol.

Benham, Leonard V. Sheet feeding devices for rotary duplicating and like machines. U. S. patent 2,876,006. Filed May 16, 1955. 3 claims. Assigned to Block & Anderson. [Cl. 271-36.]

Bond, Boyce C. Process and apparatus for treating fibrous materials. U. S. patent 2,876,063. Filed Oct. 7, 1953. 6 claims [Cl. 8-151.] An improved apparatus is provided for dyeing or otherwise treating webs of paper or the like.

Bramhill, Percy W. Dispensing cartons for cigarette packages. U. S. patent 2,875,938. Filed June 27, 1957. 1 claim. [Cl. 229-17.]

Breuer, William. Positive locking tube carton. U. S. patent 2,875,892. Filed Dec. 12, 1955. 2 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 206-65.] An open-end carton supports cylindrical packages of yarn wound on hollow in side-by-side relation.

Chambers, Herbert I. Recording paper. U. S. patent 2,876,-060. Filed Jan. 22, 1957. 1 claim. Assigned to Consolidated Electrodynamics Corp. [Cl. 346-74.] An electrosensitive direct recording paper is provided for use in a multi-channel recording oscillograph.

Chambers, Herbert I., and Browder, Lewis B. Oscillograph apparatus. U. S. patent 2,876,059. Filed June 18, 1956. 13 claims. Assigned to Consolidated Electrodynamics Corp. [Cl. 346-74.] Improvements in a direct recording oscillograph permit uniform marking of the electrosensitive recording paper used.

Cooper, John G. Cartons. U. S. patent 2,875,943. Filed Feb. 13, 1952. 3 claims. [Cl. 229-39.] A leakproof bottom is provided in a nestable popcorn carton.

Crane, Walton B. Fruit shipping crate. U. S. patent 2,875,-939. Filed Feb. 28, 1956. 6 claims. Assigned to Allied Plastics Co. [Cl. 229-27.] A multiwall, partitioned, integral-lid paperboard case is provided for shipping fruit.

Cross, Carroll N. Method for assembling display material in mount structures. U. S. patent 2,875,672. Filed Feb. 25, 1958. 4 claims. [Cl. 93-1.] A paperboard mounting support blank is wrapped about a photo or other article to be displayed.

Dorland, Rodger M., Yan, Maxwell M., and Hale, Edward C. Synthetic board and method of manufacture. U. S. patent 2,876,-153. Filed April 1, 1955. 3 claims. Assigned to Abitibi Power & Paper Co., Ltd. [Cl. 154-45.9]

Duffin, Earle R. Blockbottom multi-ply valve bag. U. S. patent 2,875,944. Filed Oct. 10, 1955. 4 claims. Assigned to The Bowater Research and Development Co. Ltd. [Cl. 229-25.]

Dunn, Lyman D. Portable food and beverage container or holder. U. S. patent 2,875,940. Filed July 23, 1957. 2 claims. [Cl. 229-30.] This is a paperboard tray with legs on one side only so that it may be rested in level position on an auto seat.

Falla, Fernando. Combined combustion apparatus for bagasse and vapor generator. U. S. patent 2,875,735. Filed May 25, 1955. 3 claims. [Cl. 122-2.]

Fowle, Irving H. Folding box. U. S. patent 2,875,936. Filed Aug. 28, 1957. 2 claims. Assigned to General Aniline & Film Corp. [Cl. 229-6.] Improved overlapping covers are pro-

vided in a paperboard carton for photo film or other sensitive material.

Jackson, Julius. Flame-retarding of textiles. U. S. patent 2,876,118. Filed Dec. 1, 1955. 15 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 106-15.] This is similar to U. S. patent 2,876,117 (March 3, 1959).

Jackson, Julius, and Siegel, Alfred. Flame-retarding of textiles. U. S. patent 2,876,117. Filed Dec. 1, 1955. 14 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 106-15.] Cellulosic materials are rendered flameproof by inclusion of iron, copper, titanium, or zirconium pyrophosphate.

Kallman, Robert I., Steinbach, Thomas M., and Stoming, Robert F. Dispensing container for sheet wrapping material. U. S. patent 2,875,891. Filed April 19, 1956. 5 claims. Assigned to Dow Chemical Co. [Cl. 206-58.]

Kumnick, Miles C., and Lontz, John F. Coating of fibrous structures with tetrafluoroethylene polymer. U. S. patent 2,876,131. Filed Nov. 23, 1954. 4 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117-47.]

Mackenzie, William A., and Stark, William H. C. Machines for lapping insulating material on to electric conductors. U. S. patent 2,875,571. Filed Jan. 13, 1958. 14 claims. Assigned to Southern United Telephone Cables Ltd. [Cl. 57-19.] Error control means are provided in a machine for wrapping paper tape about an electrical cable.

Mestre, Luis. Collating apparatus. U. S. patent 2,876,008. Filed Nov. 9, 1954. 11 claims. [Cl. 271-64.]

Mitchell, Reid L., Bampton, Robert F., and Wadman, William H. Process of forming solid particulate hydroxyethoxycellulose. U. S. patent 2,875,473. Filed Aug. 10, 1955. 3 claims. Assigned to Rayonier Inc. [Cl. 18-47.5.]

Mori, Shizuo, and Suzuki, Shigeru. Bobbin or spool. U. S. patent 2,875,961. Filed June 28, 1955. 3 claims. Assigned to Toyo Rayon Co., Ltd. [Cl. 242-118.32.] A textile bobbin comprises a metal tube crimped within a paper tube, the crimping at one end being designed to hold an identification disk.

Nelson, John B. Dispensing holder for paper containers of milk or other liquids. U. S. patent 2,875,933. Filed May 31, 1957. 4 claims. [Cl. 224-45.]

Oransky, Raymond L. Starch-coated paper-base masters for planographic printing. U. S. patent 2,876,134. Filed June 29, 1955. 5 claims. [Cl. 117-65.]

Raymond, Albert E. Abrasive structures and method of making. U. S. patent 2,876,086. Filed June 21, 1954. 12 claims. Assigned to Minnesota Mining & Mfg. Co. [Cl. 51-298.] The abrasive paper produced is characterized by uniform wearing throughout its life.

Renauer, Anton. Carrier for hectographic addressing. U. S. patent 2,875,687. Filed Nov. 6, 1956. 1 claim. [Cl. 101-149.4.] A windowed two-ply paperboard structure is provided for use as a carrier for a hectographic address label.

Robertson, Edwin J., and Craine, Joseph B. Ham package and support therefor. U. S. patent 2,876,114. Filed Sept. 1, 1955. 19 claims. Assigned to Wilson & Co., Inc. [Cl. 99-174.] A cradlelike paperboard structure is provided for supporting a wrapped ham.

Robinson, Paul C. Apparatus for heat sealing a ply of a bag tube. U. S. patent 2,875,673. Filed April 17, 1956. 8 claims. Assigned to Arkell and Smiths. [Cl. 93-20.]

Sarracino, Marcello. Tape-stretching control device for electric cable wrapping machines. U. S. patent 2,875,570. Filed Aug. 30, 1955. 7 claims. Assigned to Pirelli Societa per Azioni. [Cl. 57-13.]

Schandroch, Josef. Process of and apparatus for the continuous manufacture of cellulose or hemicellulose from cellulosic fibrous materials. U. S. patent 2,876,098. Filed Jan. 9, 1957. 18 claims. Assigned to Hans-Werner Meyer. [Cl. 92-6.] A continuous digester is designed to include both digesting and washing steps in a single vessel.

Schenk, Karl. Lens screen and method of making the same. U. S. patent 2,867,099. Filed Aug. 18, 1953. 24 claims. Assigned to Georg Hieber. [Cl. 96-45.] Use is made of a paper base coated with a layer of chromate light-sensitized regenerated cellulose which in turn carries a surface layer of a light-sensitive sliver halide composition.

Schneider, Helmuth G., and Young, David W. Wax-polyethylene-polyisobutylene. U. S. patent 2,876,204. Filed Dec. 7, 1951. 10 claims. Assigned to Esso Research and Engineering Co. [Cl. 260-28.5.] This is a nonblocking composition for coating on paper.

Sheehan, Robert E. Soil resistant textile material and method of making the same. U. S. patent 2,876,140. Filed June 30, 1955. 22 claims. Assigned to Bibb Mfg. Co. [Cl. 117-139.5.] Carboxymethylcellulose is used in a method for imparting soil resistance to textiles.

Stone, Orison W. Tray carton. U. S. patent 2,875,941. Filed Sept. 16, 1955. 5 claims. Assigned to Continental Can Co., Inc. [Cl. 229-34.] The carton is designed for simple erection despite the double spaced-wall construction included.

Torke, Erich, and König, Josef. Process of crease-proofing cellulose fibers and fabrics by applying ureaformaldehyde-glyoxal reaction products. U. S. patent 2,876,062. Filed March 4, 1954. 9 claims. Assigned to Phrix-Werke A.-G. [Cl. 8-116.2.)

Vines, Oscar L. Carton. U. S. patent 2,875,937. Filed April 11, 1955. 7 claims. Assigned to Continental Paper Co. [Cl. 229-16.] A strong, rigid, open-top berry box is formed from one paperboard blank by appropriate folding and giving operations.

Webber, Charles S. Coated abrasives. U. S. patent 2,876,087. Filed Feb. 27, 1957. 8 claims. Assigned to Norton Co. [Cl. 51-298.] Improved bonding of the abrasive particles onto the paper backing is achieved in the manufacture of abrasive paper.

Wendshuh, Herbert L. Wood grinding machine. U. S. patent 2,875,955. Filed Sept. 13, 1956. 4 claims. Assigned to The Appleton Machine Co. [Cl. 241-46.] A pulpwood grinder comprises a cylindrical housing, a feed ring rotating in the housing, and a grinding stone mounted in the feed ring and adapted to cooperate therewith in the grinding operation.

Wendshuh, Herbert L. Wood grinding machine. U. S. patent 2,875,957. Filed Nov. 14, 1956. 5 claims. Assigned to The Appleton Machine Co. [Cl. 241-97.] This is similar to U. S. patent 2,875,955 (March 3, 1959).

Wendshuh, Herbert L. Wood grinding machine. U. S. patent 2,875,960. Filed Dec. 11, 1956. 5 claims. Assigned to The Appleton Machine Co. [Cl. 241-228.] This is similar to U. S. patent 2,875,955 (March 3, 1959).

Wilson, James C. Corner construction for boxes. U. S. patent 2,875,942. Filed Sept. 5, 1956. 8 claims. Assigned to Owens-Illinois Glass Co. [Cl. 229-35.] An improved corner construction is provided in a ventilated chick-shipping carton.

Wittelshofer, Ira S. Bag-like protective wrapping for automobile bumpers and like. U. S. patent 2,875,945. Filed June 23, 1956. 3 claims. Assigned to Central States Paper & Bag Co. [Cl. 229-87.]

Zernov, Peter. Blank counting mechanism. U. S. reissue patent 24,615. Filed Nov. 17, 1958. 5 claims. Assigned to Mercury Engineering Corp. [Cl. 93-93.] Box blanks delivered from a platen press are counted into groups of predetermined number.

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Blackburn, Richard E. Paper board cask. U. S. patent 2,876,945. Filed May 21, 1956. 2 claims. Assigned to Container Corp. of America. [Cl. 229-45.] This is a cask for storing and shipping tobacco, and comprises a tubular body with end closure caps interlocked and banded in place.

Booth, Frank. Separators for electrical storage batteries. U. S. patent 2,877,136. Filed May 16, 1955. 6 claims. Assigned to British Fibrak Separator Co. Ltd. [Cl. 117-76.] A latex- and resin-impregnated paper is used.

Burman, Joseph O. Machine to crimp rims to boxes. U. S. patent 2,876,820. Filed Feb. 10, 1955. 5 claims. Assigned to Progressive Machinery Corp. [Cl. 153-1.) The machine provided fastens metal reinforcing rims onto the lips of paperboard boxes.

Coons, Frank P. Dispensing package. U. S. patent 2,876,892. Filed Aug. 2, 1955. 11 claims. Assigned to Johnson & Johnson. [Cl. 206-52.] A dispensing carton is provided for rolled material such as gauze.

Dahlquist, Carl A., Ahlbrecht, Arthur H., and Dixon, George M. Adhesive tapes and liners having low-adhesion coatings. U. S. patent 2,876,894. Filed Aug. 1, 1955. 7 claims. Assigned to Minnesota Mining & Mfg. Co. [Cl. 206-59.]

Eyster, Paul E. Combination cutter and pouring spout for cartons. U. S. patent 2,876,933. Filed July 25, 1957. 3 claims. [Cl. 222-85.]

Fleischmann, Lester K. Carbon roll. U. S. patent 2,876,885. Filed Nov. 23, 1954. 6 claims. [Cl. 197-126.] A business machine carbon roll comprises a tubular paper core with an elongated strip of carbon paper wound thereon.

Fuso, James J. Head box. U. S. patent 2,876,684. Filed Feb. 6, 1957. 3 claims. Assigned to The Sandy Hill Iron & Brass Works. [Cl. 92-44.]

Gauthier, Philippe. Paper sheathed pencils. U. S. patent 2,876,739. Filed Feb. 6, 1956. 4 claims. Assigned to Blaisdell Pencil Co. [Cl. 120-36.]

Holmes, Robert L. Polytetrafluoroethylene suction box cover for fourdrinier machines. U. S. patent 2,876,685. Filed Aug. 15, 1957. 4 claims. Assigned to Raybestos-Manhattan, Inc. [Cl. 92-51.]

Howatt, Glenn N. Forming printed circuit conductors. U. S. patent 2,876,530. Filed March 31, 1955. 14 claims. Assigned to the U. S. Secretary of the Army. [Cl. 29-155.5] An improved method is provided for forming the silver layer on a base stock of resin-impregnated material.

Leika, Walter. Method of making greeting cards and pictures.

U. S. patent 2,876,575. Filed Oct. 11, 1957. 4 claims. [Cl. 41-26.] This is a do-it-yourself greeting card kit.

Lopez, John P., and Monaghan, Alfred C. Folded box blank crushing and gluing machine. U. S. patent 2,876,731. Filed April 8, 1957. 16 claims. Assigned to Universal Corrugated Box Machinery Corp. [Cl. 118-44.]

Matthews, William R. Wood wafer cutting machine. U. S. patent 2,876,811. Filed March 12, 1956. 6 claims. [Cl. 144-162.] The wafers are for use in producing wood-particle board.

Maynard, Ralph D., Jr. Merchandise package. U. S. patent 2,876,899. Filed June 17, 1957. 4 claims. Assigned to Spencer-Hughes Corp. [Cl. 206-80.] A paperboard-backed skin pack is provided for use in the packaging of hardware items.

Moore, Forrest M. Tape coating apparatus. U. S. patent 2,876,730. Filed Feb. 8, 1957. 1 claim. [Cl. 118-43.] A small portable device is provided for use at construction sites to coat wallboard tape with crack-filling compound.

Nitchie, Charles D. Hydraulically balanced pressure roll for glue machines. U. S. patent 2,876,734. Filed April 11, 1956. 9 claims. Assigned to Samuel M. Langston Co. [Cl. 118-249.]

Port, William S., and Jordan, Edmund F., Jr. Release agents for pressure-sensitive adhesives. U. S. patent 2,876,895. Filed June 5, 1956. 2 claims. Assigned to U. S. Secretary of Agriculture. [Cl. 206-59.] Release agents are provided for coating the back side of paper backings of pressure-sensitive adhesive tapes.

Reenberg, Knud R. Carton cases. U. S. patent 2,876,944. Filed Oct. 31, 1955. 1 claim. Assigned to Philipsen & Co. [Cl. 229-37.] An improved construction is provided in a sleeve-and-drawer type carton for cigarettes.

Schwarzwälder, Karl, and Wagner, Artur. Tile composition and product suitable for floors of stables. U. S. patent 2,877,135. Filed May 12, 1955. 3 claims. [Cl. 117-70.] Wood waste is used in the molding composition used to form the title.

Shaw, Hugh H., Sanderson, Martin, and Bradshaw, Harold. Carton sealing apparatus for field crop packing machine. U. S. patent 2,876,607. Filed June 25, 1954. 5 claims. Assigned to Cochran Motors. [Cl. 53-374.]

Sisley, Leslie J. Dryers. U. S. patent 2,876,698. Filed Feb. 21, 1955. 6 claims. [Cl. 100-147.] This is a press for drying hogged fuel, including bark and wood chips.

Vander Pyl, Chester A., Jr. Method of curing porous, resin-treated pleated paper. U. S. patent 2,876,555. Filed Oct. 8, 1956. 1 claim. Assigned to Fram Corp. [Cl. 34-23.]

Vergobbi, Robert W. Packaging machine. U. S. patent 2,876,608. Filed Nov. 2, 1954. 8 claims. Assigned to Pneumatic Scale Corp., Ltd. [Cl. 53-387.] The apparatus folds and seals the closure flaps of a filled carton.

Waldron, Cloyd D. Debarker with beater rotors under the log. U. S. patent 2,876,812. Filed March 3, 1955. 4 claims. [Cl. 144-208.]

Wemyss, James C., Jr., and Schumacher, Robert A. Fibrous material product containing lanolin and method for making same. U. S. patent 2,877,115. Filed April 16, 1957. 15 claims. Assigned to Vanity Fair Paper Mills, Inc. [Cl. 92-3.] A method of incorporating lanolin into tissue paper during the manufacture thereof is described.

Will, Theodore. Guided pull tab ejector. U. S. patent 2,876,930. Filed Aug. 2, 1954. 1 claim. Assigned to Fund-Del Inc. [Cl. 221-260.] A cigarette pack is provided with a paper pull strip by means of which the first cigarettes in the pack may be partially withdrawn.

Wilson, Marion E. Method of manufacturing pipes, conduits, and like. U. S. patent 2,877,150. Filed May 11, 1955. 3 claims [Cl. 154-83.] The resin-impregnated spiral wound conduits include a corrugated board layer between layers of glass fiber.

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Aid, Joseph J., and Paxton, Edward G., Jr. Polyethylene resin coated fibrous material. U. S. patent 2,878,145. Filed Nov. 17, 1954. 3 claims. Assigned to Continental Can Co., Inc. [Cl. 117-145.] Paperboard is coated with an opaque film comprising polyethylene and aluminum flake.

Atkinson, William G. Egg carton closer. U. S. patent 2,877,610. Filed July 20, 1955. 8 claims. Assigned to Somerville Ltd. [Cl. 53-38.]

Baxter, Gene F., Schoening, Peter K., and Preusser, Henry M. Thixotropic phenol-aldehyde adhesive composition and method of making same. U. S. patent 2,878,197. Filed Feb. 18, 1954. 20 claims. Assigned to American-Marietta Co. [Cl. 260-17.5.] Methylcellulose, wood waste, and bark products are used in making a plywood adhesive.

Berney, Joseph C. Rewinding apparatus. U. S. patent 2,877,612. Filed Sept. 24, 1956. 18 claims. [Cl. 53-118.] A machine for rewinding webs of waxed paper and the like to form consumer-size rolls is provided with means for forming the roll cores and for wrapping the rewound rolls.

Blättner, Karl. Stacking device for sheet printing machines. U. S. patent 2,878,017. Filed July 30, 1957. 7 claims. Assigned to Faber & Schleicher A.-G. [Cl. 271-79.]

Bodolay, Stephen M., and Bodolay, William A. Machine for making bags from a continuous web. U. S. patent 2,877,609. Filed Sept. 17, 1957. 17 claims. [Cl. 53-28.]

Braun, Philip N. Machine for stapling identifying tags to garments. U. S. patent 2,877,695. Filed May 12, 1955. 5 claims. [Cl. 93-88.] The machine cuts the tags from a supply roll of paper tape and staples them to the garments.

Capron, Nicholas J. Isopropyl amine process for rosin acids. U. S. patent 2,878,242. Filed April 23, 1956. 7 claims. Assigned to Pennsalt Chemicals Corp. [Cl. 260-97.6.] A tall oil fractionation process involves reacting the tall oil rosin acids with isopropylamine.

Carlsmith, Lawrence A., and Rich, John P. Particle advancing apparatus. U. S. patent 2,878,116. Filed Jan. 26, 1956. 17 claims. Assigned to Improved Machinery, Inc. [Cl. 92-7.] This is similar to U. S. patent 2,878,117 (March 17, 1959).

Carlsmith, Lawrence A., and Rich, John P. Particle advancing apparatus. U. S. patent 2,878,117. Filed June 29, 1956. 2 claims. Assigned to Improved Machinery, Inc. [Cl. 92-7.] In a continuous digester for wood chips, means are provided to cause movement of the chips through the digester independently of the movement of the digesting liquid.

Chartrand, Clovis C. Protective packaging for rim fire ammunition and the like. U. S. patent 2,877,891. Filed Jan. 14, 1958. 2 claims. [Cl. 206-3.]

Crafton, John M. Method of and apparatus for producing board products. U. S. patent 2,877,491. Filed April 17, 1953. 5 claims. [Cl. 18-5.] A wood-particle board mat is produced by extrusion.

Currivan, John F. Packaging apparatus. U. S. patent 2,877,614. Filed May 1, 1957. 10 claims. Assigned to Carton Associated Inc. [Cl. 53-240.] The machine sets up and loads six-pack beer can cartons.

Forrer, Homer W. Wrapper carton incorporating center partitioning means. U. S. patent 2,877,894. Filed Feb. 13, 1958. 8 claims. Assigned to Mead-Atlanta Paper Co. [Cl. 206-65.] This is a six-pack open-end sleeve-type paperboard bottle carrier.

Gastright, Frank A. Self-erecting box with tabs and recesses for engagement by feeding and erecting mechanism. U. S. patent 2,877,943. Filed July 16, 1956. 3 claims. [Cl. 229-41.] These are open-top popcorn boxes designed to be fed, set up, and dispensed by automatic machinery.

Hebestreet, Elmer W., and Plunkett, Joseph T. Soil conditioner and process utilizing carbon black. U. S. patent 2,877,599. Filed Aug. 2, 1954. 15 claims. Assigned to said Hebestreet. [Cl. 47-9.] Spent paper mill liquors are used.

Hyman, Jerome. Two-way mailing envelope. U. S. patent 2,877,944. Filed Aug. 23, 1956. 4 claims. Assigned to Tension Envelope Corp. [Cl. 229-73.] The mailer is designed to go out under third-class postal regulations, be returned under first class.

Jorgenson, Ralph J. Frozen food package. U. S. patent 2,878,128. Filed May 2, 1955. 3 claims. Assigned to Pacific Coast Foil Co. [Cl. 99-192.] This is an aluminum foil tray covered with a foil-paper laminate.

Kamlet, Jonas. Purification of bourbonal. U. S. patent 2,878,292. Filed June 20, 1955. 2 claims. Assigned to Crown Zellerbach Corp. [Cl. 260-600.] M. 1782. A method is provided for separating bourbonal from the mixture of products obtained in the demethylation and ethylation of vanillin.

March, William A. Hydrocarbon resistant glycerol base lubricant. U. S. patent 2,878,184. Filed Dec. 29, 1953. 6 claims. Assigned to Rockwell Mfg. Co. [Cl. 252-15.] Sodium carboxymethylcellulose is used.

Markey, Frank J. Shielded web edge detector. U. S. patent 2,877,786. Filed April 3, 1956. 5 claims. Assigned to Askania Regulator Co. [Cl. 137-83.] An apparatus for sensing the position of the edge of a paper web, in which the web is passed through an air jet moving to a receiving port, is provided with means to prevent plugging of the receiver port.

Outterson, Charles R., Bell, Richard S., and Ellerson, Henry W., Jr. Process for bleaching and sizing paper pulp. U. S. patent 2,878,119. Filed March 2, 1956. 12 claims. Assigned to The Albermarle Paper Mfg. Co. [Cl. 92-21.]

Payne, Verna L. Impregnating apparatus. U. S. patent 2,877,739. Filed Dec. 7, 1956. 8 claims. Assigned to West Point Mft. Co. [Cl. 118-419.] An apparatus for impregnating a nonwoven fabric is constructed to permit easy maintenance.

Poirier, Ernest A. Suction box extraction apparatus. U. S. patent 2,877,693. Filed Jan. 11, 1957. 7 claims. [Cl. 92-51.] A suction system for a fourdrinier section adjusts its capacity automatically to the nature of the paper web and the amount of water removed therefrom; foaming and turbulence in the water removed are also reduced.

Rabchuk, Alexander. Dental impression material. U. S patent 2,878,129. Filed Dec. 7, 1953. 10 claims. Assigned to Kerr Mfg. Co. [Cl. 106-38.4.] Carboxymethylcellulose is used.

Rogers, Linwood N., Heath, Merle A., Gutliph, Earl W., and Hiett, Louis A. Purified cellulose fiber and process for producing same. U. S. patent 2,878,118. Filed Feb. 18, 1953. 3 claims. Assigned to The Buckeye Cellulose Corp. [Cl. 92-16.] The process described produces from wood a dissolving pulp for use in making viscose rayon.

Russell, John K., and Boggs, Walter W. Apparatus for handling sheets of paper. U. S. patent 2,878,016. Filed Aug. 27, 1956. 4 claims. Assigned to Luber-Finer Inc. [Cl. 271-11.] This is a printing press sheet-feeding mechanism.

Sacks, Alvin L. Moth preventive and deodorant dispensers. U. S. patent 2,878,061. Filed Oct. 22, 1957. 11 claims. Assigned to The Puro Co., Inc. [Cl. 299-24.] A cake of the active material is mounted in a paperboard holder.

Schnieder, Caspar C. Process for the manufacture of hollow articles from resin impregnated cellulosic materials. U. S. patent 2,877,498. Filed Oct. 18, 1954. 3 claims. [Cl. 18-47.5.] Dishes and the like are molded from a furnish of pulp and thermosetting resin.

Scuderi, John. Paper pattern cutting machine. U. S. patent 2,877,550. Filed July 16, 1958. 5 claims. Assigned to Eastman Machine Co. [Cl. 30-228.] A portable power-driven machine is provided to cut thick paper into patterns for use in making garments.

Sternfels, Ernest A. Recovery of metallic and nonmetallic values from sulfide and sulfide-oxide ores. U. S. patent 2,878,-102. Filed Nov. 30, 1955. 6 claims. Assigned to Continental Ore Corp. [Cl. 23-147.] This involves a process for roasting sulphur-containing ores to produce sulphur dioxide for acid plant use.

Taggart, Robert E. Carton blank feeder and gluer. U. S. patent 2,877,737. Filed July 22, 1957. 10 claims. Assigned to Lynch Corp. [Cl. 118-212.]

Thiessen, George J. Atmospheric suction roll silencer device. U. S. patent 2,877,694. Filed June 6, 1955. 3 claims. [Cl. 92-53.]

Van Antwerpen, Lloyd D. Carton with cushion cover flap. U. S. patent 2,877,942. Filed June 18, 1956. 1 claim. [Cl. 229-14.] Improved interior packing is provided in a paperboard carton for packaging a curved glass windshield.

Volckening, Lloyd I., O'Meara, John R., and Lefebvre, Frank J. Package with removable indicia-bearing sheet. U. S. patent 2,877,893. Filed April 16, 1957. 1 claim. Assigned to Ivers-Lee Co. [Cl. 206-47.] A package comprising pharmaceutical articles sealed between the plies of two sheets of packaging material is provided with a pocket for a direction sheet.

Whitmire, William E. Combination opener and dispenser for cardboard containers with inner containers. U. S. patent 2,877,-932. Filed May 8, 1957. 7 claims. [Cl. 222-83.] A metallic device is provided for attachment as a pouring spout to a cereal carton or other carton having an inner waxed paper liner.

Woofter, Cecil B. Drop pocket calender. U. S. patent 2,877,-581. Filed Nov. 5, 1956. 4 claims. Assigned to U. O. Colson Co. [Cl. 40-119.] An improved binding is provided in a wall mounted drop-leaf calender.

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Alden, Milton. Friction device for a moving web. U. S. patent 2,879,061. Filed May 24, 1954. 11 claims. [Cl. 271-2.3.] Friction means are provided in the sensitized paper-feeding mechanism of a recording instrument to stabilize the movement of the paper.

Alves, John J. Photo-mount greeting card. U. S. patent 2,879,607. Filed Aug. 12, 1955. 1 claim. [Cl. 40-158.]

Bartlett, David E., and Bartlett, Marjorie H. Sanitary device. U. S. patent 2,878,486. Filed Jan. 19, 1956. 2 claims. [Cl. 4-110.] Plastic or wax-coated paper is used to form a funnel-shaped hygienic urine conductor for women.

Clark, James d'A. Press feeding apparatus. U. S. patent 2,878,728. Filed Feb. 23, 1954. 3 claims. Assigned to Changewood Corp. [Cl. 92-61.] Means are provided to feed caul plates carrying wood fiber or particle mats to a multiple-opening hot press.

Coler, Myron A. Thermoplastic resin particles coated with conductive gel composition and method of making same. U. S. patent 2,879,234. Filed March 23, 1956. 16 claims. [Cl. 260-4.] Carboxymethylcellulose is used in making an electrically conductive molding composition.

Condo, Fred E. Composition comprising cellulose derivative, epoxy resin and epoxy curing catalyst and process for preparing same. U. S. patent 2,879,235. Filed July 21, 1953. 19 claims. Assigned to Shell Development Co. [Cl. 260-13.] The cellulosic composition may be formed into articles of improved resistance to heat and solvents.

Consaul, Kenneth E. Filing folder. U. S. patent 2,878,814. Filed Feb. 1, 1957. 1 claim. [Cl. 129-16.8] Means are provided to attach tabs designed to indicate the status of the transaction recorded in the filed material.

Donaldson, Godfrey R. Apparatus for continuous measurement of basis weight of paper, board or like fibrous material. U. S. patent 2,878,570. Filed May 8, 1956. 6 claims. Assigned to Australian Paper Mfrs. Ltd. [Cl. 33-147.]

Doskocil, John F. Foldable and portable enclosure. U. S. patent 2,878,488. Filed June 12, 1957. 6 claims. [Cl. 4-177.] A collapsible device comprising a sheet of plastic film shaped about a folding paperboard frame is claimed for use as an infant's crib or playpen.

Duke, Thomas A. Disposable container. U. S. patent 2,878,-967. Filed Feb. 25, 1953. 2 claims. [Cl. 222-107.] A flat paper container is provided for packaging a single serving of pepper, salt or the like.

Dulaney, William B. Nesting paperboard boxes. U. S. patent 2,878,983. Filed March 12, 1956. 2 claims. [Cl. 229-34.]

Edwards, Allen C. Buoyant-log debarker having bark-removing and log-rotating chains driven in opposite directions. U. S. patent 2,878,843. Filed Aug. 19, 1957. 9 claims. [Cl. 144-208.]

Gariepy, Henry J. Corner packing device. U. S. patent 2,-878,982. Filed March 26, 1958. 1 claim. [Cl. 229-14.] A corrugated paperboard interior packing element fits about the corner of an article being packaged in a carton.

Groot, Cornelis. Process and apparatus for producing molded articles. U. S. patent 2,878,727. Filed Feb. 19, 1953. 2 claims. [Cl. 92-54.] The apparatus forms pipes and other hollow articles from a furnish of asbestos fibers and hydraulic cement.

Haltmeier, Alfred. Manufacture of sulfuric acid. U. S. patent 2,879,135. Filed Mar. 21, 1955. 5 claims. Assigned to Farbenfabriken Bayer A.-G. [Cl. 23-168.]

Hennessey, Russell J., and Dunning, Robert M. Tape roll holder. U. S. patent 2,879,022. Filed Feb. 14, 1955. 3 claims. Assigned to Waldorf Paper Products Co. [Cl. 248-174.] A roll of pressure-sensitive adhesive tape is retained on a paperboard backing card.

Hildebrandt, Friedrich. Process for producing viscose solution. U. S. patent 2,879,267. Filed Dec. 20, 1955. 2 claims. Assigned to Spinnfaser A.-G. [Cl. 260-218.] The method provided achieves a more uniform reaction of alkali cellulose with carbon disulphide.

Hoppe, William. Wrapping machines. U. S. patent 2,878,-629. Filed Oct. 1, 1956. 10 claims. Assigned to Package Machinery Co. [Cl. 53-51.] A bread loaf-wrapping machine achieves proper registry of each loaf with printed material appearing on the web of wrapping material.

Hunter, Clarence S. Chemical ink. U. S. patent 2,879,168. Filed Jan. 24, 1957. 5 claims. Assigned to Eastman Kodak Co. [Cl. 106-22.] Cellulose acetate butyrate is employed in compounding an ink for use in marking photographic film.

Inman, William H. Collapsible carton. U. S. patent 2,878,-986. Filed June 1, 1956. 2 claims. Assigned to Bloomer Bros. Co. [Cl. 229-41.] This is a similar to U. S. patent 2,878,987 (March 24, 1959).

Inman, William H. Collapsible carton. U. S. patent 2,878,-987. Filed June 6, 1956. 2 claims. Assigned to Bloomer Bros. Co. [Cl. 229-41.] An automatic bottom ice cream carton is constructed so that the bottom construction does not collapse when the carton side wall is opened.

Ivy, Mary E. Container for packaging pills, etc. U. S. patent 2,878,928. Filed April 30, 1956. 1 claim. Assigned to Goodyear Tire & Rubber Co. [Cl. 206-56.] Pills are packaged in a length of plastic tubing which is coiled within a paperboard container.

Johnson, Carl N. Multiple tag stringing machine. U. S. patent 2,878,729. Filed Nov. 22, 1957. 15 claims. Assigned to Johanson & Son Machine Corp. [Cl. 93-91.] The machine provided inserts string simultaneously in a number of baggage tabs and knots the string.

Jullander, Elof I. Methods of improving the dissolution of high-molecular substances. U. S. patent 2,879,268. Filed Dec. 28, 1954. 14 claims. Assigned to Mo Och Domsjo AB. [Cl. 260-232.] The water or alkali solubility of cellulose ethers is increased by treating the ethers with formaldehyde or glyoxal.

Kilty, Michael F., Jr. Apparatus for making non-woven fibrous webs. U. S. patent 2,878,526. Filed March 5, 1956. 2 claims. [Cl. 19-155.]

Kryeske, Raymond. Coin mailer. U. S. patent 2,878,988. Filed Oct. 2, 1956. 3 claims. [Cl. 229-92.9] The mailer is constructed of corrugated and flat paper layers.

Leupold, Curt W. Pocket handkerchief package and method of packaging same. U. S. patent 2,878,929. Filed June 21, 1956. 1 claim. Assigned to Vereinigte Papierwerke Schickedanz & Co. [Cl. 206-57.] Half the pile of handkerchiefs packaged may be removed without unwrapping the other half.

Linström, Nils H. Multiple-layer floor boards. U. S. patent 2,878,530. Filed May 3, 1955. 4 claims. [Cl. 20-7.] The assembly includes a core of compressed pulp or sawdust.

Miller, Ivan K. Chemical composition and process. U. S. patent 2,879,170. Filed Oct. 2, 1957. 9 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 106-165.] Regenerated

cellulose filaments of improved strength and other properties are formed.

Mitchell, Norval W. Label applying apparatus. U. S. patent, 2,878,953. Filed Jan. 4, 1957. 1 claim. Assigned to Borden Co. [Cl. 216-55.]

Neer, William. Catalogue order card binder. U. S. patent 2,878,813. Filed June 15, 1956. 3 claims. Assigned to Jewell Tea Co., Inc. [Cl. 129-1.] A looseleaf binder retains inventory sheets and order cards so that a running inventory of stock on hand may be kept.

Newell, Kenneth F. Web supply means. U. S. patent 2,879,-063. Filed Aug. 30, 1957. 6 claims. Assigned to Package Machinery Co. [Cl. 271-2.3.] Improved tensioning means are provided in the web-supplying feeding apparatus used in a wrapping machine.

Paulsen, Hans C. Tape coating and dispensing apparatus. U. S. patent 2,878,777. Filed March 1, 1956. 1 claim. Assigned to United Shoe Machinery Corp. [Cl. 118-43.] The machine coats paper tape with a heated pressure-sensitive adhesive, then cools, dries, severs, and dispenses the tape.

Rossum, Robert T. Package for sliced bacon and the like. U. S. patent 2,878,985. Filed Feb. 1, 1956. 2 claims. [Cl. 229-40.] Bacon slices are arranged in flat overlapping form on a stiff paper supporting member and the assembly is overwrapped in plastic film.

Sager, Leonard H. Display package unit. U. S. patent 2,878,933. Filed April 29, 1958. 13 claims. Assigned to Soriano Ceramics, Inc. [Cl. 206-79.] A display card is provided for supporting a decorative ceramic tile.

Skinner, Eugent S. Paper machine drum arrangement. U. S. patent 2,879,039. Filed Jan. 18, 1957. 4 claims. Assigned to Beloit Iron Works. [Cl. 257-95.] The drum is constructed so that it may be used with steam as a drying cylinder or with water as a cooling drum.

Sorg, Adam. Method of producing heat sealable filter paper for making infusion packages. U. S. patent 2,879,172. Filed March 11, 1957. 11 claims. Assigned to Adam Sorg and Edwin V. Hadley. [Cl. 117-11.]

Tarin, Lillian. Pouring spout for cartons. U. S. patent 2,878,966. Filed Feb. 14, 1957. 7 claims. [Cl. 222-90.]

Then, Edward O. Carrying device for containers. U. S. patent 2,878,930. Filed Dec. 23, 1955. 18 claims. Assigned to American Can Co. [Cl. 206-65.] Paperboard and metal elements are used to unitize two flat-top paperboard milk cartons.

Tomlinson, George H., II. Method and apparatus separating dirt from aqueous suspensions of pulp fibres. U. S. patent 2,878,934. Filed Nov. 1, 1957. 6 claims. Assigned to Howard Smith Paper Mills Ltd. [Cl. 209-211.] The hydrocyclone also removes air.

Waltz, Edward. Roll paper cutter attachment. U. S. patent 2,878,980. Filed Dec. 12, 1955. 2 claims. Assigned to E. O. Bulman Mfg. Co., Inc. [Cl. 225-39.] The cutter element is adapted to be slipped over the dispensing lip of a carton containing a roll of waxed paper or the like.

Welshenbach, Charles D., and Aust, John J. Article packaging means. U. S. patent 2,878,984. Filed May 6, 1957. 3 claims. Assigned to West Virginia Pulp & Paper Co. [Cl. 229-37.] A bottomless paperboard cover is provided for storage batteries.

Wirkkala, Albert R. Mechanical means for extending the operating radius of a log loading boom. U. S. patent 2,878,946. Filed Nov. 25, 1957. 1 claim. [Cl. 212-7.]

Yundt, Albert P., and Bradway, Keith E. Method of preparing starch and urea-formaldehyde adhesive and product obtained. U. S. patent 2,879,236. Filed June 7, 1956. 4 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 260-17.3.] This is an adhesive or size for paper.

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Bergstein, Frank D., and Nerenberg, Robert W. Bottom closures for lined cartons. U. S. patent 2,879,933. Filed March 18, 1953. 13 claims. Assigned to Bergstein Packaging Trust [Cl. 229-14.]

Bowditch, William R., Jr. Insulating material. U. S. patent 2,879,827. Filed Oct. 11, 1954. 23 claims. Assigned to Taylor Fibre Co. [Cl. 154-2.6.] A laminating resin is provided for use in making humidity-resistant dielectric paper laminates.

Burgon, William J., and Zenczak, Piotr. Process of separating a crude composition obtained from bark into its component parts. U. S. patent 2,880,216. Filed Oct. 29, 1956. 10 claims. [Cl. 260-397.25.]

Carter, Paul H. Resilient paper covers for containers and method of manufacture. U. S. patent 2,879,935. Filed March 13, 1957. 2 claims. Assigned to Maryland Cup Co. [Cl. 229-43.] A paper cover for a paper cup is formed so as to have a resilient flange.

Comstock, Alfred E. Pulp molding machine. U. S. patent 2,879,697. Filed July 16, 1952. 14 claims. Assigned to Diamond Gardner Corp. [Cl. 92-56.] This is similar to U. S. patent 2,879,696 (March 31, 1959.)

Cote, Omer E. Vacuum box blank feeder mechanism. U. S. patent 2,879,994. Filed Aug. 30, 1956. 3 claims. Assigned to U. S. Automatic Box Machinery Co., Inc. [Cl. 271-11.]

Cox, John W. Pulp molding machine. U. S. patent 2,879,-696. Filed July 10, 1952. 15 claims. Assigned to Diamond Gardner Corp. [Cl. 92-56.] A multiple-die pulp molding machine is provided with means to transfer the articles from the forming dies to drying forms.

Cunningham, George L. Electrolytic process. U. S. patent 2,880,147. Filed Feb. 13, 1956. 3 claims. Assigned to Horizons Inc. [Cl. 204-3.] Ethyl- and methylcellulose are used in a process for electrodepositing a metal on a cathode.

De Mario, Joseph. Tea bag tags. U. S. patent 2,879,613. Filed April 24, 1957. 1 claim. [Cl. 40-2.] A tea bag tag is designed to interlock with the handle of the tea cup so that it cannot slip back into the tea.

Feigley, David A., Jr. Asbestos-backed plastic surface covering. U. S. patent 2,880,090. Filed Nov. 20, 1956. 20 claims. Assigned to Armstrong Cork Co. [Cl. 92-3.] Asbestos fibers are beater-saturated with a synthetic rubber and a magnesium polyacrylate, sheeted, and coated with a vinyl layer to produce a floor-covering material.

Fleissner, Hans, and Fleissner, Gerold. Drier of the sieve-drum type. U. S. patent 2,879,607. Filed May 5, 1955. 2 claims. Assigned to Firma Fleissner & Sohn Maschininfabrik. [Cl. 34-114.] Increased capacity and reduced size is achieved in a sieve drum drier for cellulose flakes or heavy fibers.

Flynn, Thomas E. Carton. U. S. patent 2,879,934. Filed Aug. 14, 1956. 4 claims. Assigned to Fort Wayne Corrugated Paper Co. [Cl. 229-27.] Erection of a corrugated board egg case automatically positions a central case-partitioning panel.

Flynt, James W., and Suda, Stanley. By-product and heat recovery from residual liquor. U. S. patent 2,879,838. Filed June 8, 1955. 6 claims. Assigned to Babcock & Wilcox Co. [Cl. 159-4.] Spent pulping liquors are concentrated so that they have sufficient solids content for self-sustaining combustion.

Groves, James H., and Lenane, Daniel J. Method of dispersing rubbery polymers in aqueous media. U. S. patent 2,880,-184. Filed July 20, 1954. 5 claims. Assigned to American Can Co. [Cl. 260-3.] The composition may be employed in coating paper.

Hawtin, Selwyn G., and Downing, John. Manufacture of textile and other materials having a basis of cellulose triacetate. U. S. patent 2,880,106. Filed Jan. 9, 1957. 9 claims. Assigned to British Celanese Ltd. [Cl. 106-193.]

Hiler, Malvern J. Dextran containing sizing composition. U. S. patent 2,880,105. Filed Sept. 2, 1955. 2 claims. Assigned to Commonwealth Engineering Co. of Ohio. [Cl. 106-162.] The aqueous paper sizing and coating composition also contains dodecyloxymethyl dimethyl β-methyl-β-formyl propyl ammonium chloride.

Hill, Robert L. Machine for loading containers in a carton. U. S. patent 2,879,638. Filed May 14, 1956. 10 claims. Assigned to Morgan Packing Co., Inc. [Cl. 53-166.] This is a bottle case loader.

Hindle, Thomas. Flexible hinges. U. S. patent 2,879,580. Filed March 9, 1956. 12 claims. [Cl. 28-78.] An impoved fastening is provided for use in butt-joining a paper machine drier felt.

Hurley, James R. Cement compositions and process of cementing wells. U. S. patent 2,880,096. Filed Dec. 6, 1954. 17 claims. Assigned to Phillips Petroleum Co. [Cl. 106-31.] Sodium carboxymethylhydroxyethylcellulose is used.

Labombarde, Raymond A. Folding apparatus for leading flaps. U. S. patent 2,879,699. Filed Feb. 26, 1957. 9 claims. [Cl. 93-49.] The leading flaps of a box blank are folded while the previously folded trailing flaps are held in folded condition.

Mehltretter, Charles L., Van Cleve, John W., and Watson, Paul R. Preparation of starch-bisulphite addition products. U. S. patent 2,880,236. Filed Nov. 20, 1956. 2 claims. Assigned to U. S. Secretary of Agriculture. [Cl. 260-513.] The products are of use in adhesives and paper sizes.

Nowotny, Glenn J. Primary battery. U. S. patent 2,880,-259. Filed June 18, 1954. 11 claims. Assigned to Electric Storage Battery Co. [Cl. 136-111.] Starched paper is used to form a bibulous electrolyte carrier in a flat cell battery.

Rankin, Walter J., and Tungseth, Barry F. Reinforced abrasive articles and intermediate products. U. S. patent 2,880,080. Filed Nov. 7, 1955. 11 claims. Assigned to Minnesota Mining & Mfg. Co. [Cl. 51-297.] An air-laid web of coated glass fibers and cotton thread segments is used as the base sheet in producing sandpaper.

Richardson, Ralph R., and Castner, John F. Cellular tray forming and assembling machine. U. S. patent 2,879,700. Filed Oct. 24, 1955. 9 claims. Assigned to United Biscuit Co. of America [Cl. 93-97.]

Scholl, Edward C. Water reducible texture paint. U. S. patent 2,880,104. Filed Sept. 26, 1955. 1 claim. Assigned to United Gilsonite Laboratories. [Cl. 106-128.] Methylcellulose and other cellulose ethers are used.

Schroeder, Arthur C. Package handling apparatus. U. S. patent 2,879,637. Filed Oct. 17, 1956. 2 claims. Assigned to Schroeder Machines Corp. [Cl. 53-61.] The machine provided fills a corrugated paperboard shipping container with a number of packages.

Scozzafava, Milton V., and Busch, Richard E. Paper feeding device. U. S. patent 2,879,993. Filed May 21, 1957. 3 claims. Assigned to Clary Corp. [Cl. 271-2.1.] Improved threading is provided in paper-feeding mechanisms of business machines in which pin wheels cooperate with perforations in the paper to effect the feeding.

Simons, Lawrence E. Combined container and dispenser. U. S. patent 2,879,931. Filed Sept. 16, 1954. 2 claims. Assigned 49% to Phyllis G. Herman. [Cl. 225-25.] A flat cylindrical container of the type used for packaging paper-backed pressure-sensitive paper tape is modified to permit its use as a dispenser.

Spinelli, John J. Plasterboard construction. U. S. patent 2,879,662. Filed Nov. 13, 1957. 8 claims. [Cl. 72-124.] The paper facing sheets of gypsum board are formed of perforated paper so as to improve the water-absorption rate of the paper.

Triolo, Louis. Machine for combining sheets. U. S. patent 2,879,698. Filed Oct. 15, 1957. 7 claims. [Cl. 93-36.6.] The machine adhesively unites paper labels or wrappers and box blanks.

Walsh, Paul R., and Mohr, George D. Feeding apparatus for fibrous particles. U. S. patent 2,879,904. Filed Nov. 19, 1956. 6 claims. Assigned to Clear Fir Products Co. Inc. [Cl. 214-17.] The machine forms a mat of wood particles.

Watkins, Daniel H. Booklet having attached thereto a writing pad for receiving temporary images. U. S. patent 2,879,609. Filed Dec. 23, 1953. 3 claims. Assigned to Watkins-Strathmore Co. [Cl. 35-62.]

Watkins, Daniel H. Test booklet having readily erasible answer sheet. U. S. patent 2,879,608. Filed April 10, 1956. 2 claims. Assigned to Watkins-Strathmore Co. [Cl. 35-31.]

Wheeler, Donald B. Heat reflective insulation. U. S. patent 2,879,554. Filed Nov. 28, 1958. 28 claims. Assigned to Union Bag-Camp Paper Corp. [Cl. 20-4.] An insulating structure, formed of paper and aluminum foil is provided for nailing between studs in building construction.

Williams, Warren D. Binder for conductive metallic film. U. S. patent 2,880,181. Filed Nov. 2, 1956. 4 claims. Assigned to Sperry Rand Corp. [Cl. 252-514.] Various cellulose ethers and esters are used in formulating the coating.

Zuercher, Anthony J. Wrapper applying machine for newspapers. U. S. patent 2,879,636. Filed Jan. 23, 1957. 9 claims. Assigned to T. W. & C. B. Sheridan Co. [Cl. 53-53.]

Zurek, Chester A. Folded carton processing machine. U. S. patent 2,879,701. Filed Dec. 6, 1956. 10 claims. [Cl. 93-53.] The machine feeds, sets up, and forwards folding boxes.

The following patents were received later than those of the same issue date, and have accumulated during the first Quarter of 1959.

July 29, 1958

Siegrist, Adolf E., and Ackermann, Franz. Oxdiazole compounds. U. S. patent 2,845,419. Filed Feb. 6, 1956. 10 claims. Assigned to Ciba Ltd. [Cl. 260-240.] Various oxidiazole compounds are claimed as optical brightening agents for use in paper and textiles.

August 19, 1958

Arabian, Karekin G., and Duncan, Norman E. Gloss stable paraffin wax compositions. U. S. patent 2,848,385. Filed Oct. 10, 1955. 6 claims. Assigned to Shell Development Co. [Cl. 196-149.] These compositions are of use in coating paper and board.

August 26, 1958

Shott, John H., III, Lighthipe, Charles H., and Ward, John E. Liquid defoaming compositions. U. S. patent 2,849,405. Filed Dec. 28, 1953. 15 claims. Assigned to Nopco Chemical Co. [Cl. 252-358.] The composition, which may contain tall oil, is of use in inhibiting foam in a paper mill white water system.

September 2, 1958

Stickel, Wesley N. Battery separator and method of making same. U. S. patent 2,850,559. Filed Jan. 10, 1955. 10 claims. Assigned to Texon, Inc. [Cl. 136-145.] A resin-impregnated alpha-cellulose battery separator is provided with an improved ribbed construction.

September 16, 1958

Knight, Cryil H., and Varcoe, Lorne C. Method of and apparatus for clarifying liquids. U. S. patent 2,852,138. Filed Sept. 4, 1956. 3 claims. Assigned to Dorr-Oliver Inc. [Cl. 210-83.] The apparatus is of use in processing green liquor in the kraft pulping process.

Moonan, George E. Apparatus or preparing residual liquor. U. S. patent 2,852,348. Filed April 5, 1954. 5 claims. Assigned to Babcock & Wilcox Co. [Cl. 23-262.] The apparatus mixes spent pulping liquor with make-up chemicals and the like and delivers the prepared mixture to the spray nozzles of a chemical recovery furnace.

September 23, 1958

Wimmer, Ernest L. Water-insoluble complex of quaternary ammonium salt, a heavy-metal oxide, and an organic colloid and method of preparing same. U. S. patent 2,853,414. Filed Dec. 2, 1953. 8 claims. Assigned to American Sugar Refining Co. [Cl. 167-22.] Bactericidal and fungicidal properties are imparted to paper by depositing the complex *in situ* therewithin.

October 14, 1958

Weisgerber, Cyrus A. Stable ketene dimer-emulsifier mixtures and their preparation. U. S. patent 2,856,310. Filed Feb. 15, 1955. 15 claims. Assigned to Hercules Powder Co. [Cl. 106-287.] A ketene dimer emulsion is prepared for use in treating paper.

October 21, 1958

Iler, Ralph K. Polyethylene-estersil composition. U. S. patent 2,857,355. Filed Oct. 27, 1953. 2 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 260-41.] The compositions described are used in wax-coating, flameproofing, and sizing paper.

Thomas, Walter M. Unsaturated polyester resin composition containing as a catalytic promoter alkyl amino styrenes. U. S. patent 2,857,358. Filed March 24, 1954. 9 claims. Assigned to American Cyanamid Co. [Cl. 260-45.5.] The resin is of use in impregnating and laminating paper.

October 28, 1958

Hastings, John V., III, and Schoenberg, Andrew A. Laminated flexible sheet material. U. S. patent 2,858,248. Filed July 3, 1953. 4 claims. [Cl. 154-47.] A paper base is laminated to a metallized film to produce a decorative material.

Melamed, Sidney. Vinyl sulfides of substituted ureas and thioureas, polymers thereof, and methods for making them. U. S. patent 2,858,297. Filed July 15, 1955. 20 claims. Assigned to Rohm & Haas Co. [Cl. 260-77.5.] These products are of use in adhesives, fungicides, coatings, wet-strength agents for paper, etc.

November 4, 1958

Othmer, Donald F. Process for concentrating acetic acid and other lower fatty acids using entrainers for the acids. U. S. patent 2,859,154. Filed Sept. 26, 1955. 1 claim. [Cl. 202-42.] The acids are recovered from black liquor.

November 18, 1958

Arden, Thomas V., Burstall, Francis H., Davies, Glynn R., Linstead, Reginald P., and Wells, Ronald A. Production of metals and their compounds. U. S. patent 2,860,956. Filed April 18, 1949. 2 claims. Assigned to United States Atomic Energy Commission. [Cl. 23-309.] Cellulose pulp or filter paper is employed in preparing pure metals from impure natural sources.

Bower, Fred C. Web winding machine. U. S. patent 2,860,839. Filed Feb. 24, 1953. 7 claims. Assigned to The Black-Clawson Co. [Cl. 242-56.]

Carasso, Fred M. Process for reclaiming and improving saline and alkaline soils. U. S. patent 2,860,448. Filed April 11, 1955. 5 claims. [Cl. 47-58.] Calcium lignosulphonates are used.

Cox, Norman L. Regenerated cellulose structures and process for producing them. U. S. patent 2,860,480. Filed April 18, 1956. 8 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 57-140.] High-tenacity rayon filaments are obtained by adding to the viscose various compounds which reduce the gel swelling of the fibers by at least 10%.

Guyer, Reynolds. Product encircling band. U. S. patent 2,860,824. Filed April 2, 1954. 5 claims. Assigned to Waldorf Paper Products Co. [Cl. 229-40.] A diecut paperboard band is used in packaging a group of frankfurters or the like.

Moser, William C. Chemical process. U. S. patent 2,861,039. Filed March 9, 1955. 3 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 210-32.] A carbon bed is reactivated after use in separating hemicelluloses from the caustic liquor used for steeping cellulose in the viscose process.

Touey, George P., and Kiefer, John E. Method of preparing cellulose esters. U. S. patent 2,861,069. Filed March 21, 1957.

8 claims. Assigned to Eastman Kodak Co. [Cl. 260-227.] Noncombining esterification catalysts are provided.

Young, James H. Bleaching fibers of vegetable origin with formamidine sulfinate and alkaline peroxide. U. S. patent 2,860,944. Filed Nov. 28, 1955. 9 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 8-104.]

November 25, 1958

Harvey, Mortimer T., and Rosamilia, Peter L. Acid polymerization of butadiene 1,3-furfural reaction product. U. S. patent 2,861,978. Filed June 9, 1954. 10 claims. Assigned to Harvel Research Corp. [Cl. 260-67.] The polymerized products are of use in impregnating and laminating paper.

Pritchard, James E. Addition products of heterocyclic nitrogen polymers and heavy metal salts, method of impregnating with, and impregnated article. U. S. patent 2,861,902. Filed Sept. 7, 1954. 23 claims. Assigned to Phillips Petroleum Co. [Cl. 117-138.5.] These products are of use in treating paper, etc., to impart water repellency and resistance to fungi, insects, etc.

December 2, 1958

Gatsis, John G. Treatment of wood tar distillate. U. S. patent 2,862,975. Filed Dec. 10, 1956. 5 claims. Assigned to Universal Oil Products Co. [Cl. 260-613.] The dimethyl ethers of 5-alkyl-pyrogallols are recovered.

Meyer, Edwin W., and Circle, Sidney J. Acylated, isolated, partially-hydrolyzed, soya protein and process. U. S. patent 2,862,918. Filed March 12, 1956. 7 claims. Assigned to Glidden Co. [Cl. 260-123.5.] A soya protein product is provided, suitable for use as the binder in paper coatings.

December 9, 1958

Bonzagni, Francis A. Process for the preparation of sulfite modified melamine-formaldehyde resin and product obtained. U. S. patent 2,863,842. Filed May 23, 1956. 8 claims. Assigned to Monsanto Chemical Co. [Cl. 260-29.4.] The resin is of use in wet-strengthening paper.

Shelanski, Morris V., and Winicov, Murray W. Iodine chloride preparation for controlling microorganisms. U. S. patent 2,863,798. Filed Nov. 5, 1956. 7 claims. Assigned to West Laboratories, Inc. [Cl. 167-17.] The composition is applicable to papermaking processes.

December 23, 1958

Allen, Edward M., and Chisholm, Raymond S. Method of preparing a siliceous pigment. U. S. patent 2,865,777. Filed July 6, 1955. 5 claims. Assigned to Columbia-Southern Chemical Corp. [Cl. 106-288.] The pigments have a larger average ultimate particle size than those now available, and are readily filterable from aqueous media.

Hurwitz, Marvin J., and de Benneville, Peter L. Diaminopolysiloxanes. U. S. patent 2,865,918. Filed June 1, 1955. 7 claims. Assigned to Rohm & Haas Co. [Cl. 260-247.5.] The compounds provided are of use in imparting water repellency and dimensional stability to paper.

Toothill, Frederick W., Jr., Stieber, Joseph A., and Hatton, Harold L. Aqueous coating compositions, articles coated therewith, and methods for producing them. U. S. patent 2,865,878. Filed Sept. 26, 1955. 20 claims. Assigned to Rohm & Haas Co. [Cl. 260-29.6.] The coating composition may be applied to paper and to other materials.

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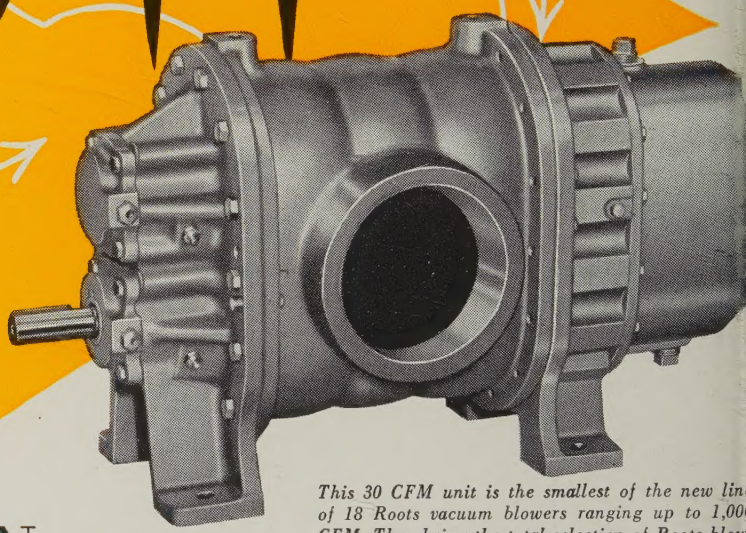

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